METZ FARMS 2 LTD.

SURFACE WATER & GROUNDWATER MONITORING RESULTS

APRIL TO OCTOBER, 2000

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N.B. Department of the Environment and Local Government
Sciences and Reporting Branch

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Executive Summary

The New Brunswick Department of the Environment and Local Government is conducting a monitoring program of surface and well water quality in the vicinity of Sainte-Marie-de-Kent, NB. The purpose of this program is to assess the effects of land application of liquid manure generated at Metz Farms on local surface and well water quality.

While numerous water quality variables were measured, this early review of the data concentrates on fecal coliform bacteria as indicators of the degree of manure contamination. Future reports will consider all variables as more data become available.

Results from sampling 27 surface water stations representing ten land areas, and background samples from 82 domestic wells are presented. Post-spreading results are presented for 9 domestic wells (one land application area) and six land areas. Difficulty in distinguishing between various sources of bacteria, plus the temporal variability of surface water quality during rainfall events, presented obstacles to the interpretation. Bearing this in mind, these results provide no conclusive evidence that manure application affected the bacterial quality of drainage waters and well water in the study area.

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1.0 INTRODUCTION

On August 30, 1999, Metz Farms was issued a license (#LO-0006) to operate a piggery at Saint-Marie-de-Kent (Figure 1) under Section 5(1) of the New Brunswick Livestock Operations Act administered by the New Brunswick Department of Aquaculture, Fisheries and Agriculture. Manure management involved applying stored liquid manure on nearby farm fields in the spring and fall. The license required certain restrictions on manure application to minimize impacts on water quality including: timing of application, setbacks near water courses, restrictions on slope and soil characteristics where spreading was to take place and specified application rates.

The New Brunswick Department of Environment and Local Government (NBDELG) is conducting a monitoring program to determine the effects of manure management on both surface and well water. Only a portion of the program has been completed to date, and at this early stage, the data resulting from the limited number of samples collected can only provide preliminary impressions of the effects of manure application. While water was analyzed for numerous variables, the uncertainties associated with the small number of samples does not justify an in-depth review of all variables at this time. This report therefore, focuses on fecal coliform (FC) bacteria concentrations as indicators of the extent of manure contamination. In the future, when a more complete set of results becomes available, all variables will be considered in producing monitoring reports.

1.1 Background

The Ministerial Monitoring Committee for Metz Farms 2 Ltd. was formed and made up of staff from the New Brunswick departments of: Environment and Local Government; Agriculture, Fisheries and Aquaculture; Natural Resources and Energy; and Health and Wellness. Other organizations represented included Fisheries and Oceans Canada, the Local Service District, the Cooperative des Huitres de Bouctouche, the Agri-Conservation Club, Sustainable Development at Northumberland Strait and the Southeastern Anglers Association.

The mandate of this committee was to develop a surface and ground water quality monitoring plan. Ultimately, the plan would help to determine if, and to what extent, manure applications affected surface and ground water quality in the area. The surface water sampling stations were designated by this committee, and the monitoring plan called for sites to be sampled routinely. Surface water sampling was also to be done after a rainfall of 25mm or greater within a 24 hour period. Ground water was to be sampled three to four times per year.

2.0 METHODS

2.1 Surface Water

Twenty-seven sampling stations were established to represent the quality of water originating from ten land areas (Fig.1B).

Between April 25 and October 29, NBDELG staff (Moncton Regional Office and Sciences and Reporting Branch) collected samples one to five times at each station in accordance with established protocols. Samples were submitted to the NBDELG laboratory and analyzed for 34

variables including major ions, metals, nutrients, physical characteristics and bacteria. Analyses were conducted using standard methodologies.

2.2 Groundwater

A survey of water quality in domestic water wells was intended to encompass homeowners in the vicinity of the fields where spreading of the liquid manure (generated at Metz Farms) was expected to occur. Local residents were contacted in person, or when not available, by letter to explain the program, and who to contact if interested. Interested homeowners were then asked to complete a questionnaire (Appendix A) to provide information pertaining to their wells (depth, age, location, any treatment). Of the 93 homeowners surveyed, 82 agreed to participate in the sampling program, 7 did not respond to the survey and 4 declined to participate.

Samples were taken in accordance with accepted techniques at 82 wells in August through October, and analyzed for 26 variables at the NBDELG laboratory in Fredericton using standard techniques. Post spreading samples were analyzed for bacteria only.

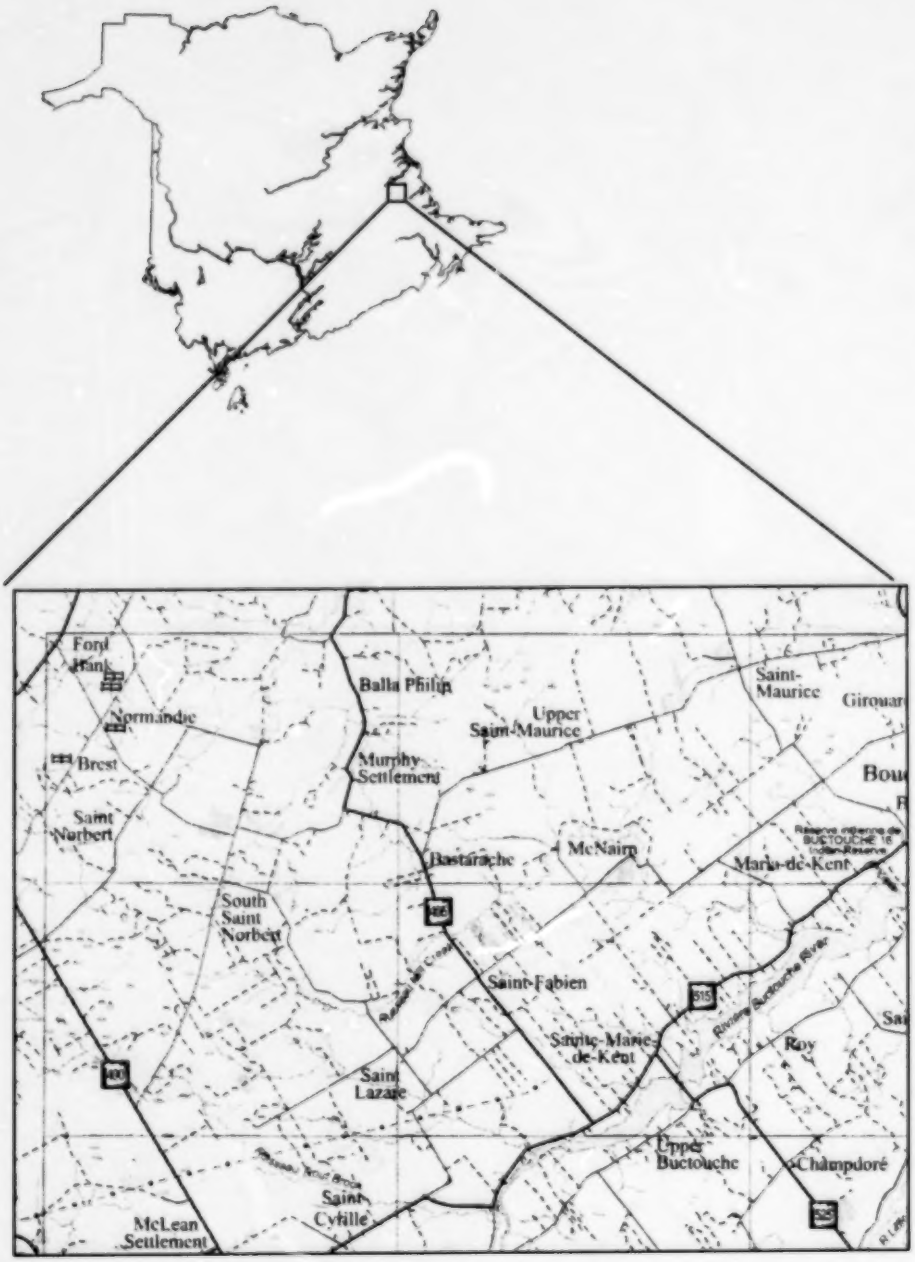


Figure 1: Study Area

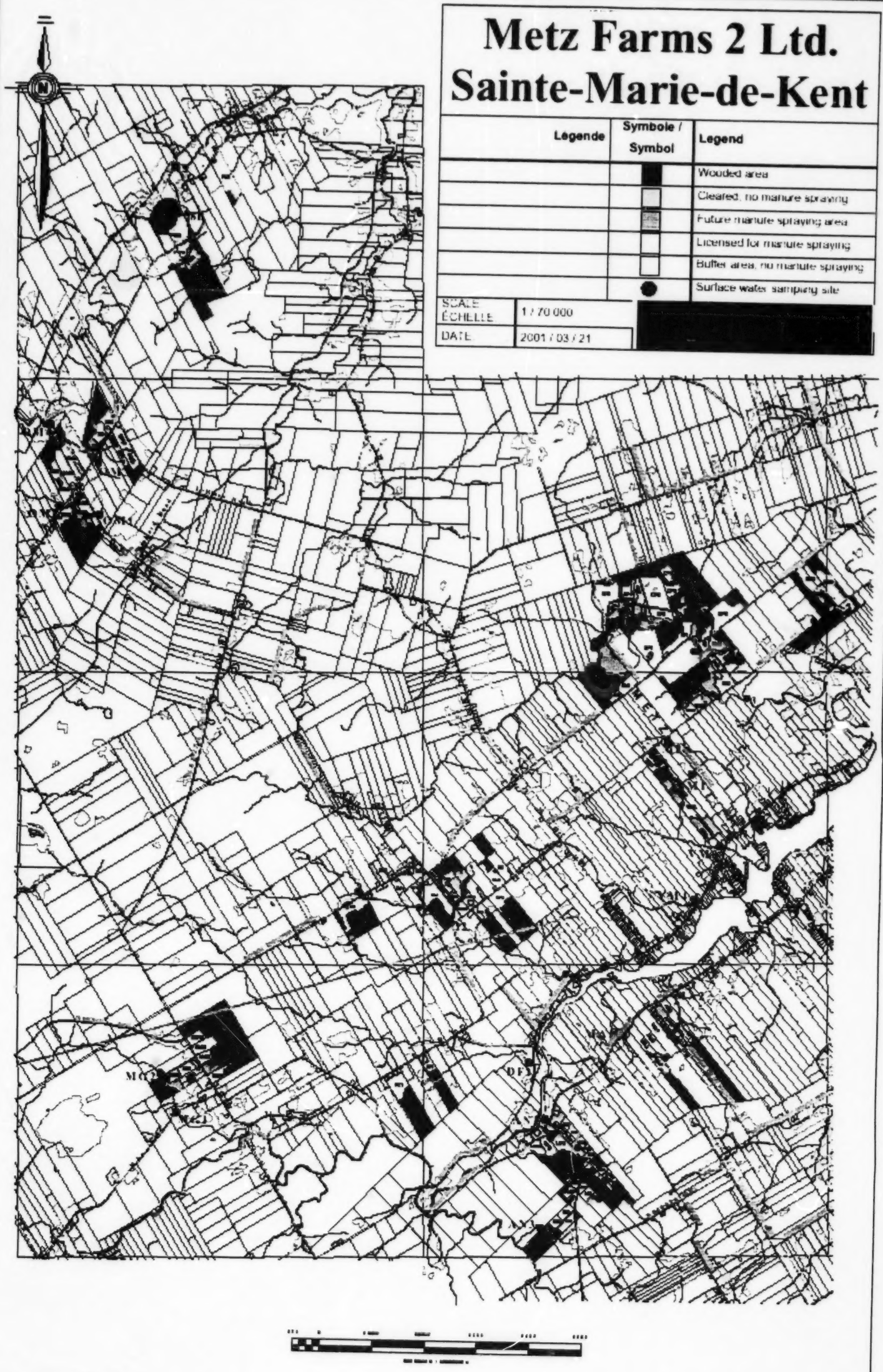

Metz Farms 2 Ltd.
Sainte-Marie-de-Kent
Légende
Symbole / Symbol
Legend
Wooded area
Cleared, no manure spraying
Future manure spraying area
Licensed for manure spraying
Buffer area, no manure spraying
Surface water sampling site
SCALE
ÉCHELLE
1 / 70 000
DATE
2001 / 03 / 21

FIGURE 2

2.3 Other Data

Details of liquid manure spreading (volumes, dates etc) were kindly provided by the Department of Agriculture, Fisheries and Aquaculture, Moncton Regional Office.

Rainfall data for the Moncton airport for the months of April to October were extracted from NBDELG files.

3.0 RESULTS

3.1 Spreading Information

Spreading of the liquid manure was performed in the spring of the year (June 01-15, 2000) and again in the autumn (October 11-27, 2000) (Table 1). Department of Agriculture, Fisheries and Aquaculture staff were on hand to witness most of the spreading activity to ensure that setbacks, application rates, etc. met required standards.

Table 1. Spreading information, Metz Farms, 2000

Field Identification	# of Loads Estimated Max. Volume (3750 Igal/load)	Dates spread (Year 2000)
Part of CP3	6	June 1
FW2	83	June 6, 12
BM8, BM9, part of BM7	62	June 13
Part of BM5, BM6	15	June 13 (night)
Last of BM7, BM3, north side of BM2	64	June 14
Section of CP3	25	June 14 (night)
CP2	53	June 15
BM4	7	June 15
VM1	24	October 12, 23, 24, 25
VM5	6	October 24
VM6	38	October 23, 24
CP1	80	October 11, 12
MA2, MA3, MA8	86	October 13, 14, 18, 23
MA10	12	October 13
AN1, AN2, AN3, AN4	40	October 26, 27
LC11, LC12, LC13	29	October 25, 26
AN 20, AN21, AN22	16	October 25, 26
AN19, AN23	10	October 25, 26
AN16	7	October 26
AN8, AN9, AN10	6	October 27

3.2 Rainfall

Total rainfall amounts prior to each surface water sampling run were: 15 mm, April 25; 0 mm, May 23; 27 mm, June 8; 6 mm, June 27-28; 0 mm, July 31- August 1; 9 mm, August 21; 25 mm, September 16; 41 mm, October 19; 58 mm, October 29 (Fig. 3).

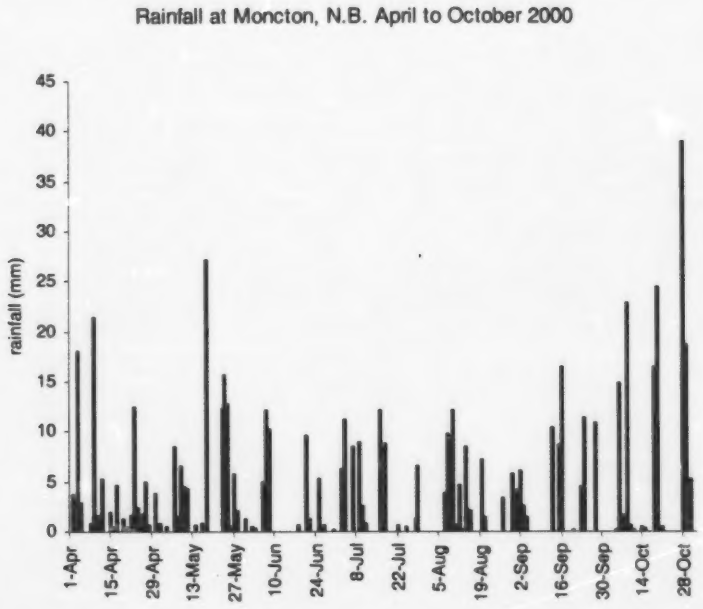


Fig. 3. Rainfall at Moncton, N.B., April to October 2000

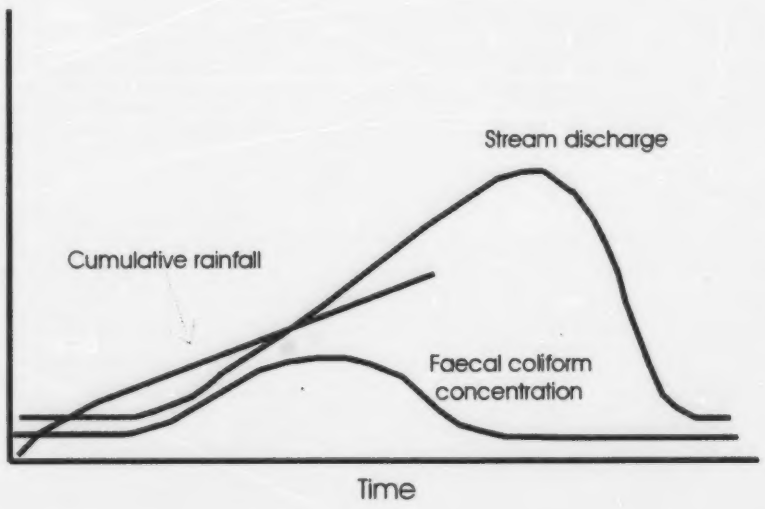


Fig. 4: Hypothetical relationship between stream discharge, rainfall and bacteria concentration

3.3 Surface water quality

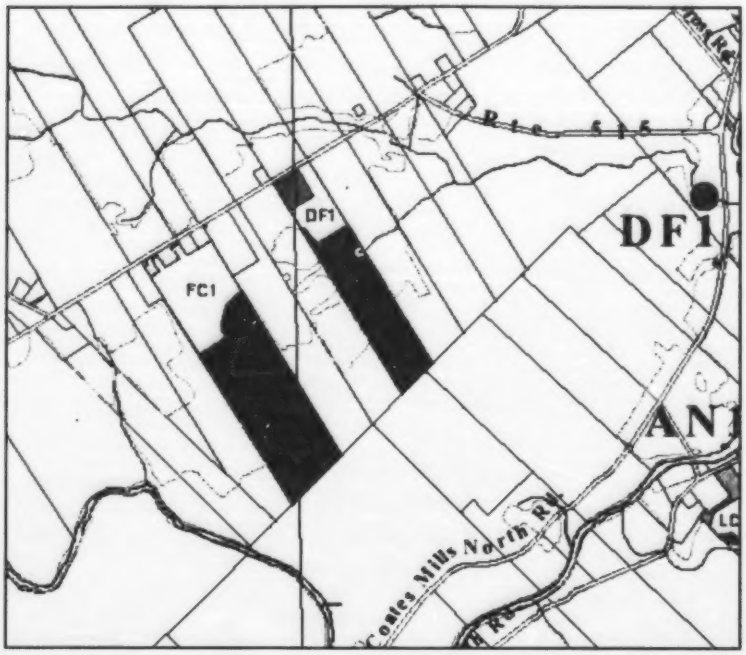
Only the fecal coliform bacteria results are presented in this section. Data for all parameters measured are to be considered in future reports.

The results for each area are organized according to livestock usage or non usage and manure spreading history.

The following relates sampling results to rainfall events. It must be remembered that water quality may change a great deal over the course of a rainfall event (Fig. 4), and field personnel had no way of knowing at precisely what point in the runoff cycle samples were being collected. Therefore, caution must be exercised when interpreting results, particularly when comparing results for specific stations and/or dates. Thus, conclusions drawn from the data must be tempered by the fact that results obtained during an event could be as much related to the timing of sample collections as to the effects of manure application.

A further complicating factor was the fact that livestock were pastured on some of the treatment areas. When fecal coliform were detected in drainage from these areas, the portion originating from the manure and that from the pastured livestock could not be determined.

3.3.1 Areas with no livestock pastured and no Metz Farm manure applied



Areas DF1 and FC1

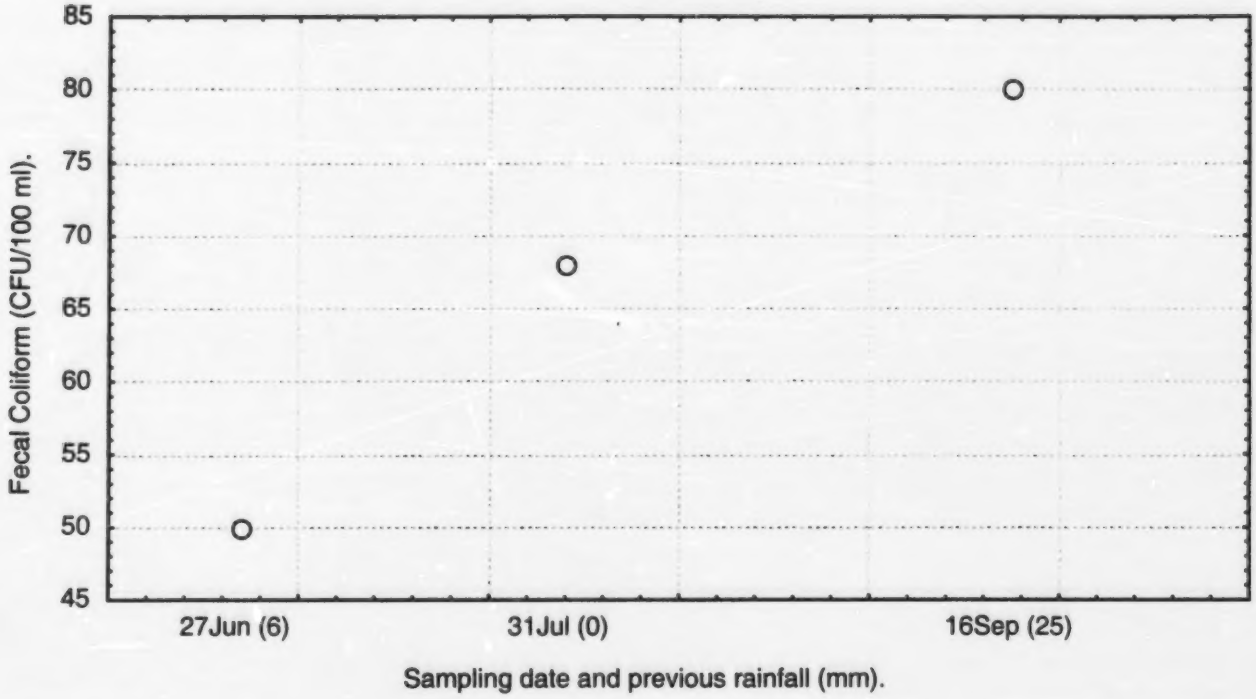
Livestock – none known to be pastured in the drainage area.

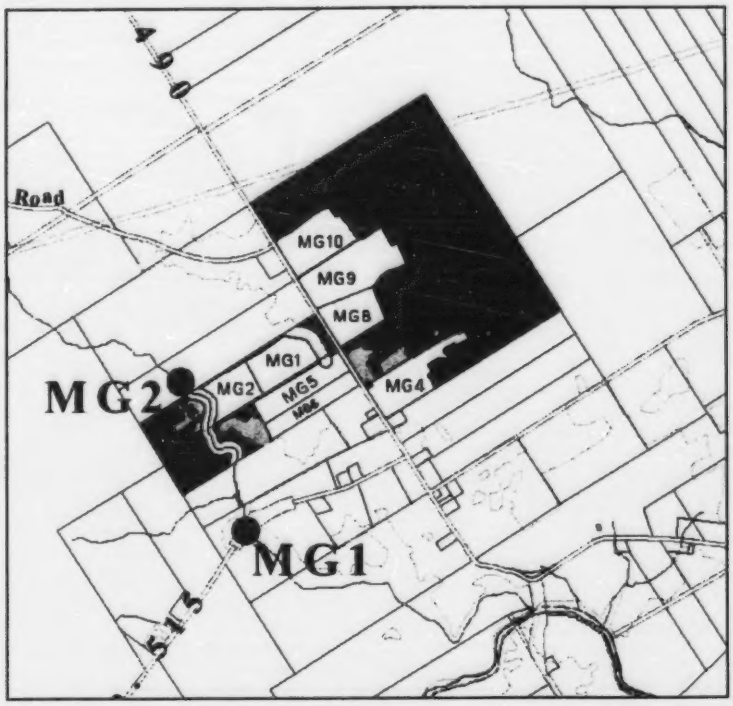
Manure application – not treated, could therefore temporarily serve as a reference area

Fecal Coliform (FC) ***results*** – see Fig. 5

Comments:
Values remained below 100 CFU/100 ml, but the station was not sampled when heavy rainfall occurred in October. A slight increase in FC was measured after the smaller rainfall event in mid-Sept. Value as a temporary reference station is limited by gaps in sampling frequency.

Fig. 5. Fecal Coliform, Metz Farm study, Station DF1.
June-Sept, 2000.





Area MG

Livestock – none known to be pastured in the area.

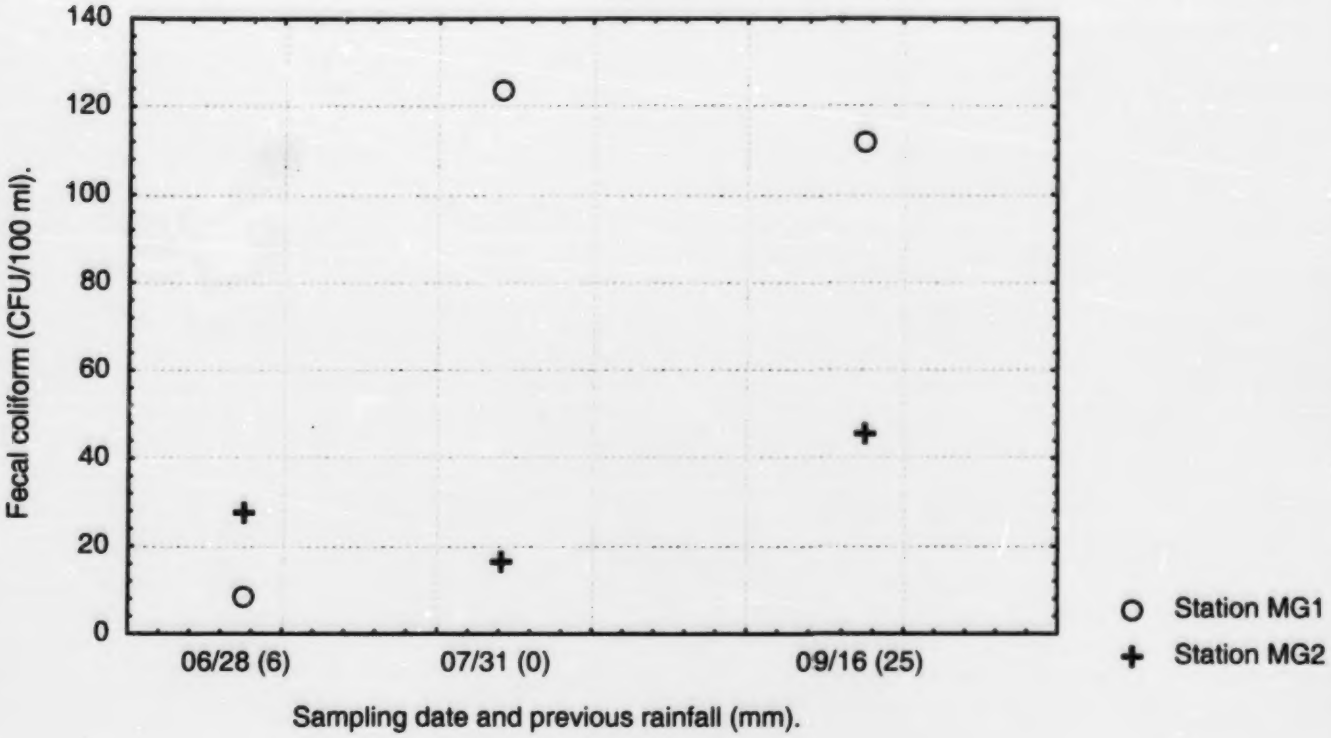
Manure application – none

Fecal Coliform results – see Fig. 6

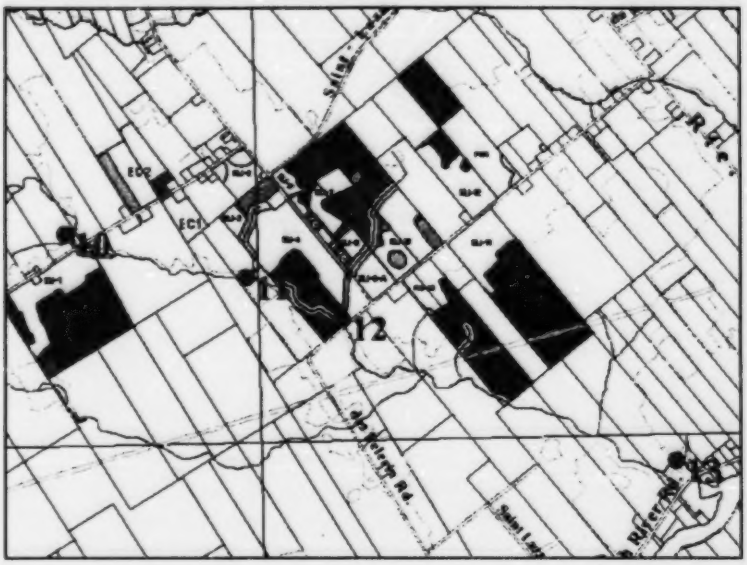
Comments

May temporarily serve as a reference site. The rainfall events of October were not sampled. Measurements at MG 2 (upstream station) were less than those from the downstream station (MG 1) two of three times. Since these stations were not sampled in October, effects of the major storms (Fig. 3) could not be determined.

Fig. 6. Fecal coliform, Metz Farm study,
stations MG1 and MG2, June-Sept, 2000.



3.3.2 Livestock pastured, no Metz farm manure applied



Areas EC,KL,PW

Livestock – 50 cows on Area EC

Manure application – none

Fecal coliform results – see Fig. 7

Comments

Site #10 – upstream (background) station. FC were lowest in May and June, increased to 183 CFU/100 ml in late July and 620 CFU/100 ml on August 21st. They declined to 140 CFU/100 ml in mid September, but increased to 1,080 CFU/100 ml after the heavy rain in late October.

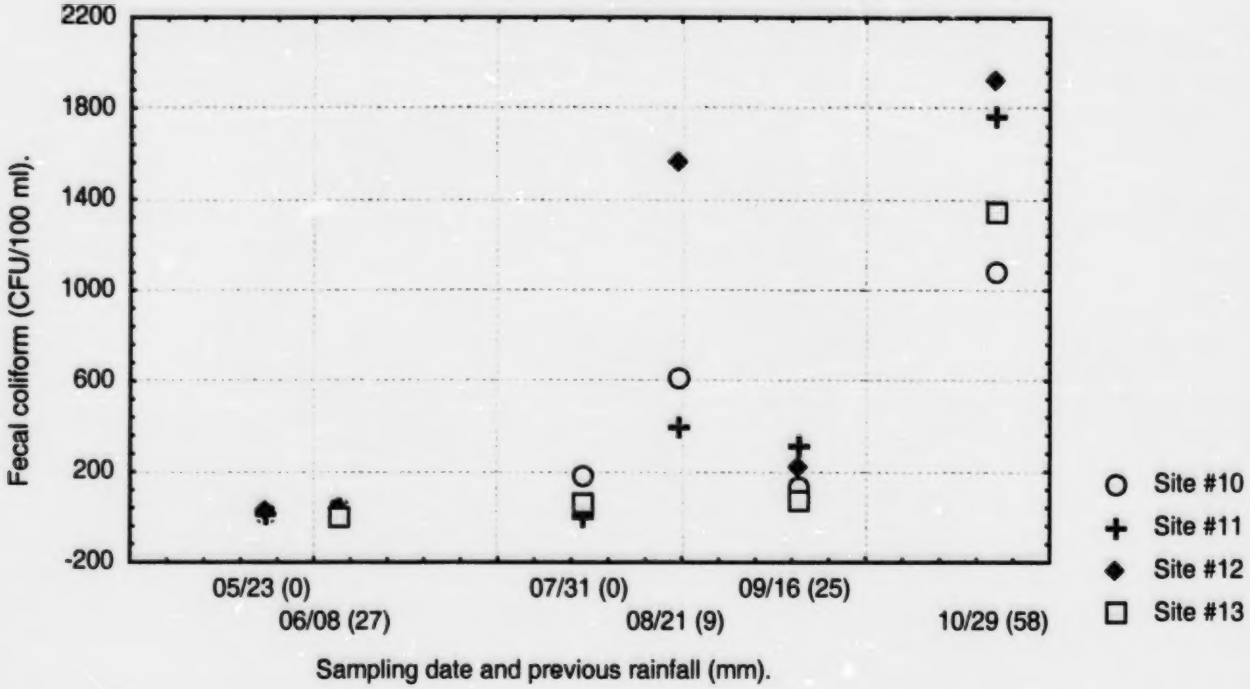
Site #11 – downstream of Site #10, but upstream of most of the fields proposed for treatment. FC fluctuations were of the same pattern as the background station, and the values were of similar magnitude.

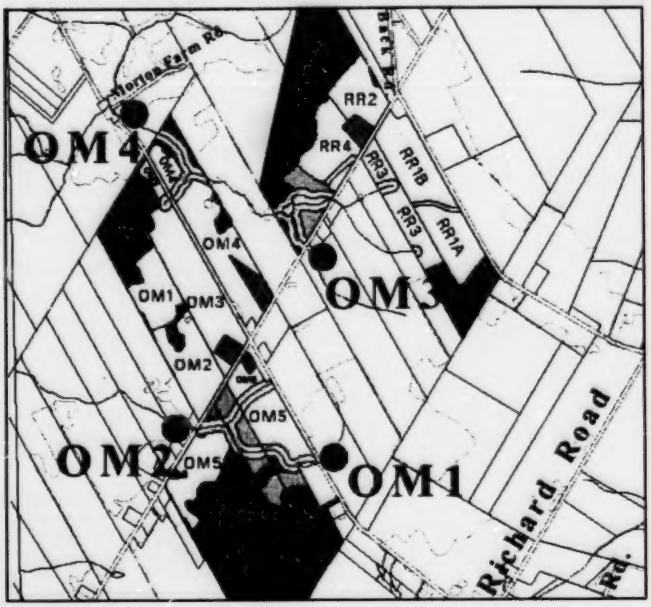
Site # 12 – downstream of most of the fields proposed for manure application. The pattern and magnitude of FC values were similar to the previous two sites. Values tended to exceed background.

Site #13 – downstream of all fields proposed for treatment, near the confluence with the Bouctouche River. FC values were very similar to background.

It appears that rainfall had some effect on FC counts. The increases after rainfall were similar at all stations. These results may represent conditions resulting from normal land use practices in the absence of application of the Metz Farm manure.

Fig.7. Fecal coliform, Metz Farm study,
sites #10, #11, #12, #13, May-Oct, 2000.





Areas OM and RR

Livestock – 40 cows on OM

Manure application – none.

Fecal coliform results – see Figs. 8 and 9

Comments

Site OM1 – background station, upstream of OM fields. FC were less than 10 CFU/100 ml on all three dates including September 16th, which was preceded by the 25 mm rainfall.

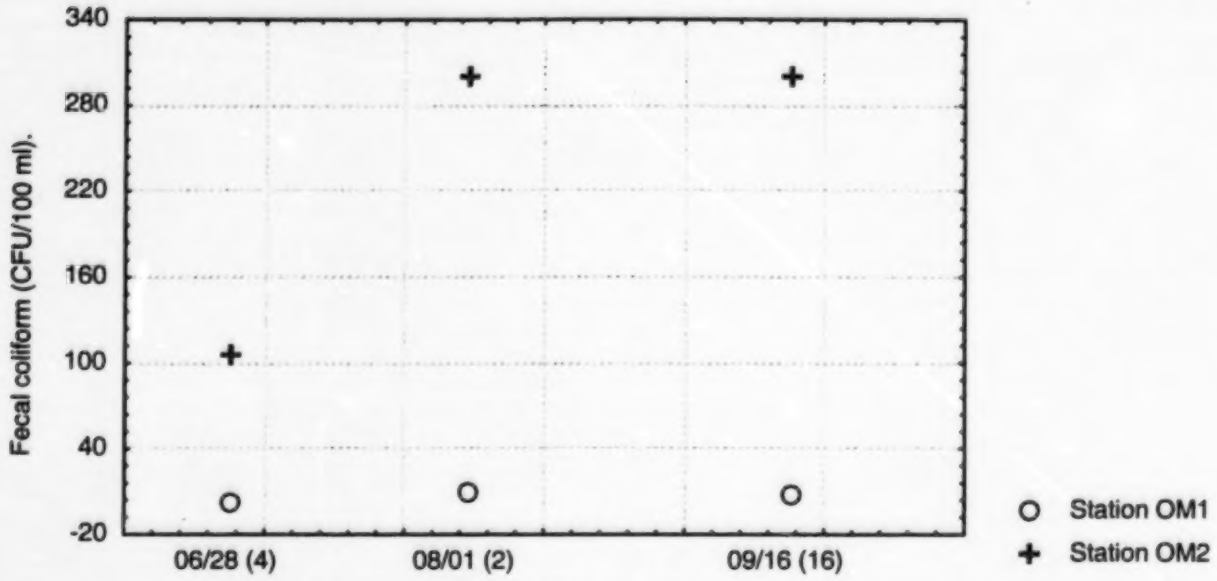
Site OM2 – downstream of fields designated OM5. FC were low in late June, but increased to >300 CFU/100 ml in early August and mid-September. The August increase was not associated with a significant rainfall. A true impression of the extent of the increases could not be determined because of the > values.

Site OM3 – located on the upstream portion of a tributary draining portions of areas RR and OM. It could be considered to be a background station. FC appeared to be high at >300 CFU/100 ml in late June and 1,560 CFU/100 ml in early August. No value was available for mid-September. The high counts were measured during dry periods.

Site OM4 – downstream of RR and OM. Readings for June and September were low. The August result of >300 CFU/100 ml was not specific enough to compare with the result at the upstream station.

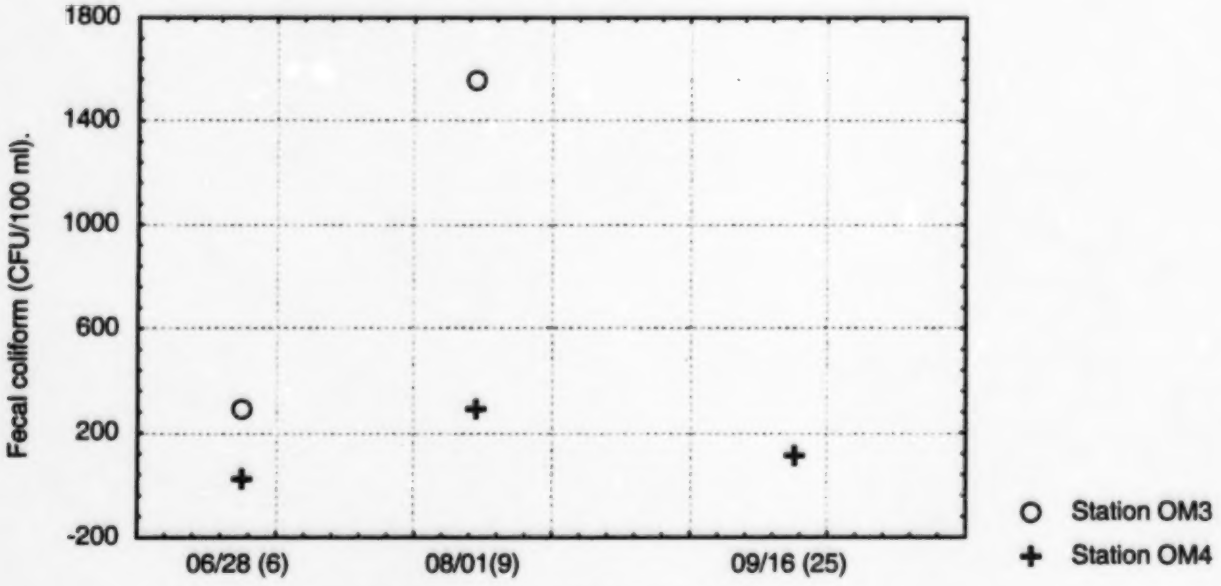
Since no manure application took place in the drainage, the data may represent the results of normal land use in the area.

Fig. 8. Fecal coliform, Metz Farm study,
stations OM1 and OM2, June-Sept, 2000.



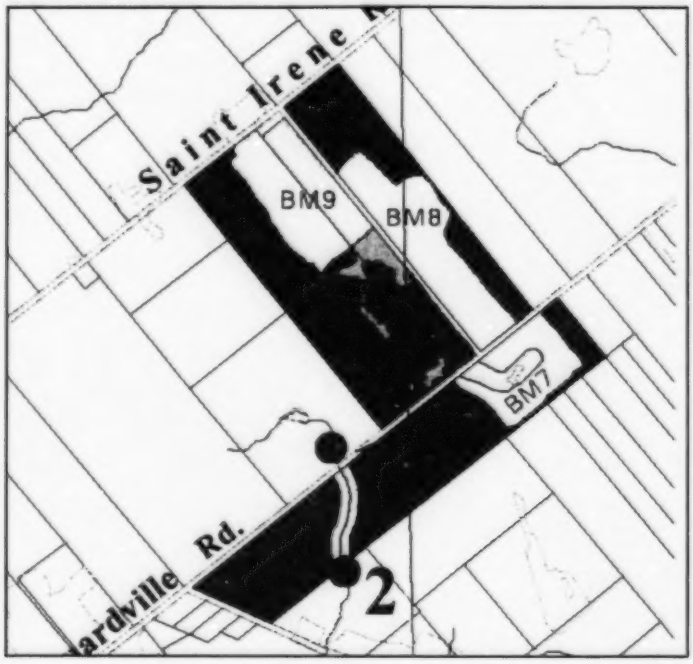
NOTE: FC at OM2, 08/01 & 09/16, >300 CFU/100ml
Sample date and previous rainfall (mm).

Fig. 9. Fecal coliform, Metz Farm study,
stations OM3 and OM4, June-Sept, 2000.



NOTE: FC at OM3, 06/28 & OM4, 08/01, >300 CFU/100 ml
Sampling date and previous rainfall (mm).

3.3.3 No livestock pastured, Metz farm manure applied



Areas BM 7,8,9

Livestock – none

Manure application – Areas BM 7,8,9 – spring (June 13), 62 loads*
Remainder of Area BM 7 – spring (June 14), 64 loads (also includes application to Areas BM2,3)

Fecal coliform results – see Fig. 10

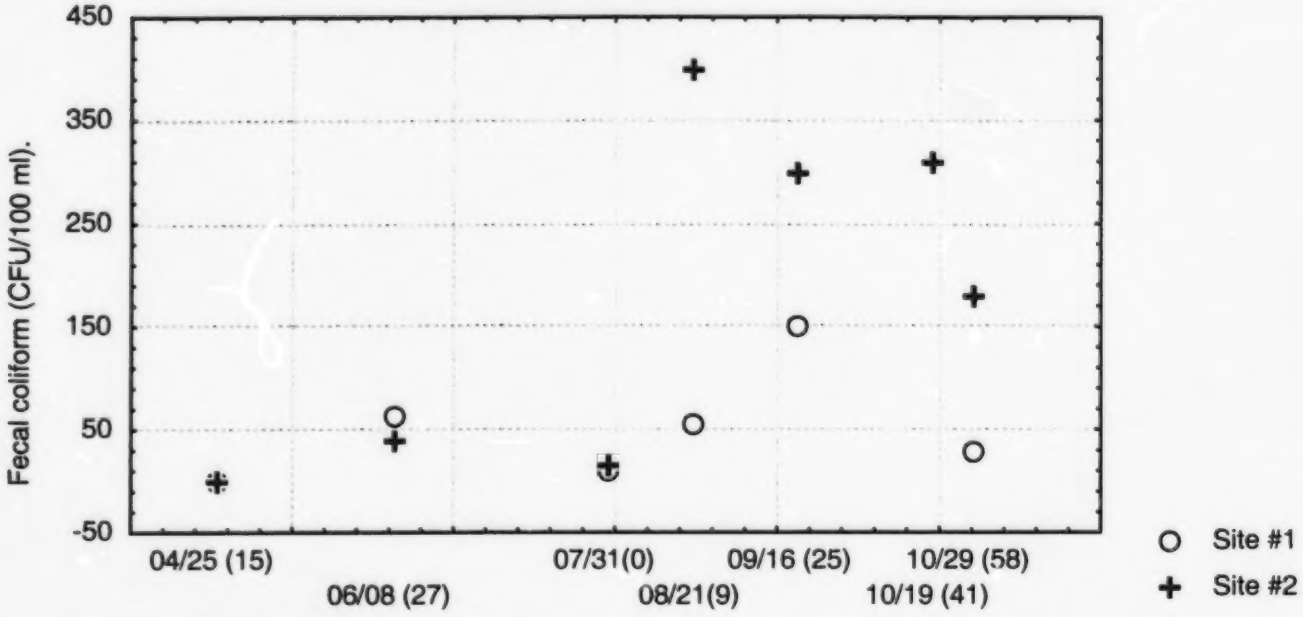
Comments

Site #1 – upstream site on a stream draining a wooded area. The stream was a considerable distance from the treated areas. All FC counts were low with a maximum of 152 CFU/100 ml.

Site #2 – downstream site. FC counts from April to July were low. From August to October, they were consistently higher than at Site #1, but the difference is not considered to be great. However, it appears that some bacteria entered the stream as it passed through the wooded area. The distance of the sampling sites from the treated areas, and the fact that manure was applied more than two months prior to the August sampling, indicate that the increase probably did not result from the manure application.

* Maximum volume of a load is estimated to be 3,750 Imperial gallons

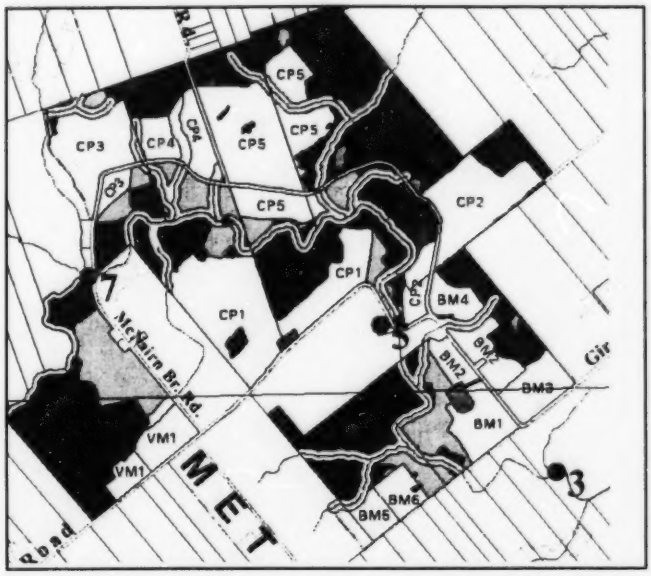
Fig.10. Fecal coliform, Metz Farm study,
sites #1 and #2, April-Oct, 2000.



NOTE: FC at #2, 09/16, >300 CFU/100ml

Sampling date and previous rainfall (mm).

3.3.4 Livestock pastured, Metz farm manure applied



Areas CP and BM

Livestock - CP 350 cows
BM 80 cows, 20 heifers, 20 horses

Manure Application -

Field CP 1	fall (Oct. 11 and 12, 2000) 80 loads
Field CP 2	spring (June 15, 2000) 53 loads
Field CP 3	spring (June 1 and 14, 2000) 31 loads
Field BM 2 and 3	spring (June 14, 2000) 64 loads
Field BM 4	spring (June 15, 2000) 7 loads
Field BM 5 and 6	spring (June 13, 2000) 15 loads
Field VM1	fall (October 12, 23, 24, 25) 24 loads

Fecal coliform results – See Fig. 11

Comments

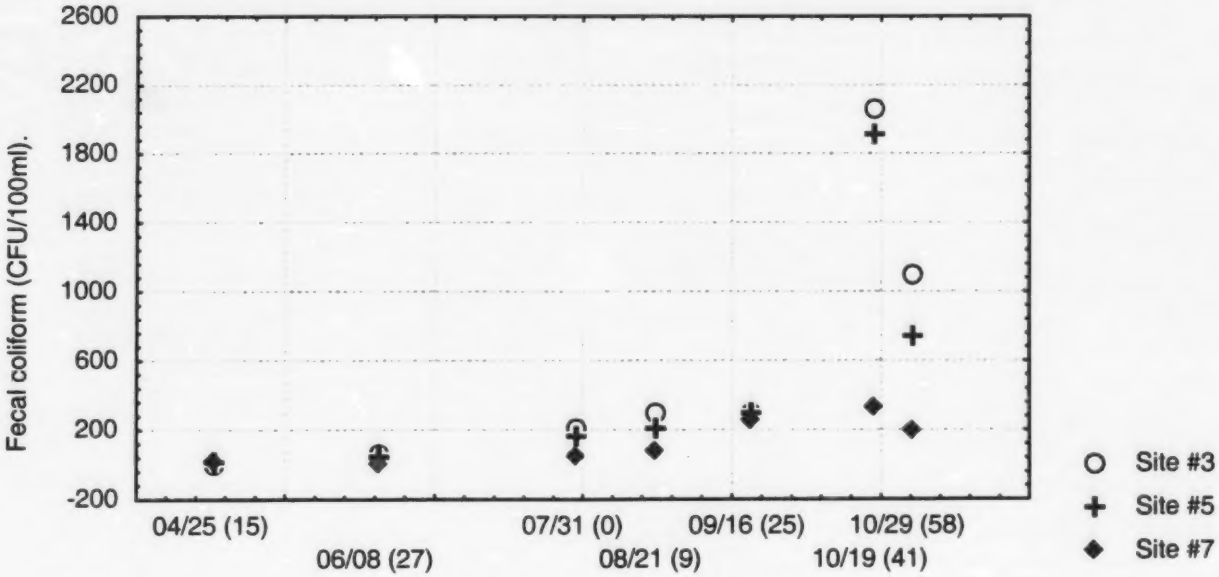
Site #7 – background, upstream of treated area; FC were low in spring and early summer but increased somewhat in September and October, apparently in response to rainfall events in those months.

Site #5 – located about two thirds the distance down the drainage from Site #7. A large portion of the treated area as well as community pasture were upstream of this site. FC increased well above background in October when major rainfall events took place. The >300 CFU/100 for September 16 does not give an indication of how high values actually were. Livestock were pastured in the CP fields all summer and probably influenced the bacteria count. However, the relative amounts originating from the pastured animals and the piggery waste are not discernible.

Site #3 – downstream of areas where Metz manure was applied. FC increased in October, and possibly August, but the >300 value again did not indicate the magnitude of the increase. Overall, the increase appeared to be of similar degree as that at Site #5. Again, the sources of FC could not be distinguished.

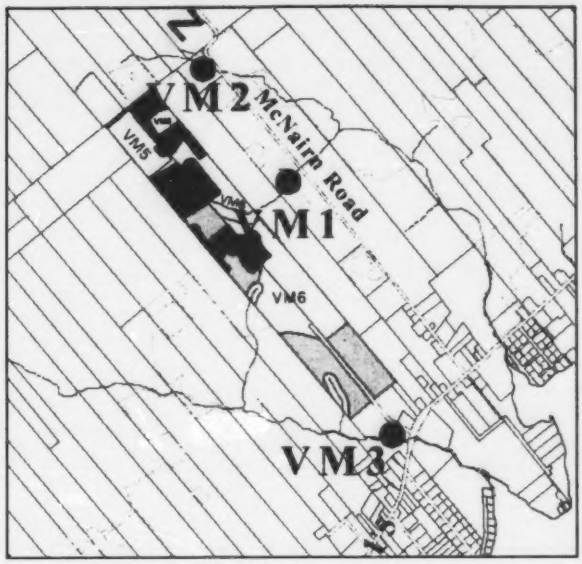
In summary, the heavy rains of September and October appeared to have little effect on FC values at the background station, but values at stations downstream of treated areas increased. Most loads of manure were applied in mid June, and would not be expected to affect values on July 31 and later due to expiry of the bacteria. The fall application took place before the rain events, and could have affected FC counts, but being only a portion of the total applied, along with the confounding factor of the pastured livestock, it cannot be concluded that the manure application had a significant effect on the stream.

Fig. 11. Fecal coliform, Metz Farm study, sites #3, #5, #7, April-Oct, 2000.



NOTE: FC at #3, 08/21 & 09/16, #5, 09/16, >300 CFU/100ml

Sampling date and previous rainfall (mm).



Area VM

Livestock – 40 cows

Manure Application – Field VM 5 fall (October 24), 6 loads
Field VM 6 fall (October 23,24), 38 loads

Fecal coliform results – see Figs. 12,13,14

Comments -

Site VM 4 (not shown on map) - drained an area that was **not** treated. Land use in the drainage was considered to be typical of that throughout the area – mostly hay fields, some cattle. FC were low in late June (Fig. 12), but increased to >300 CFU/100 ml in late July. The rainfall of only 2 mm did not explain the increase seen in FC.

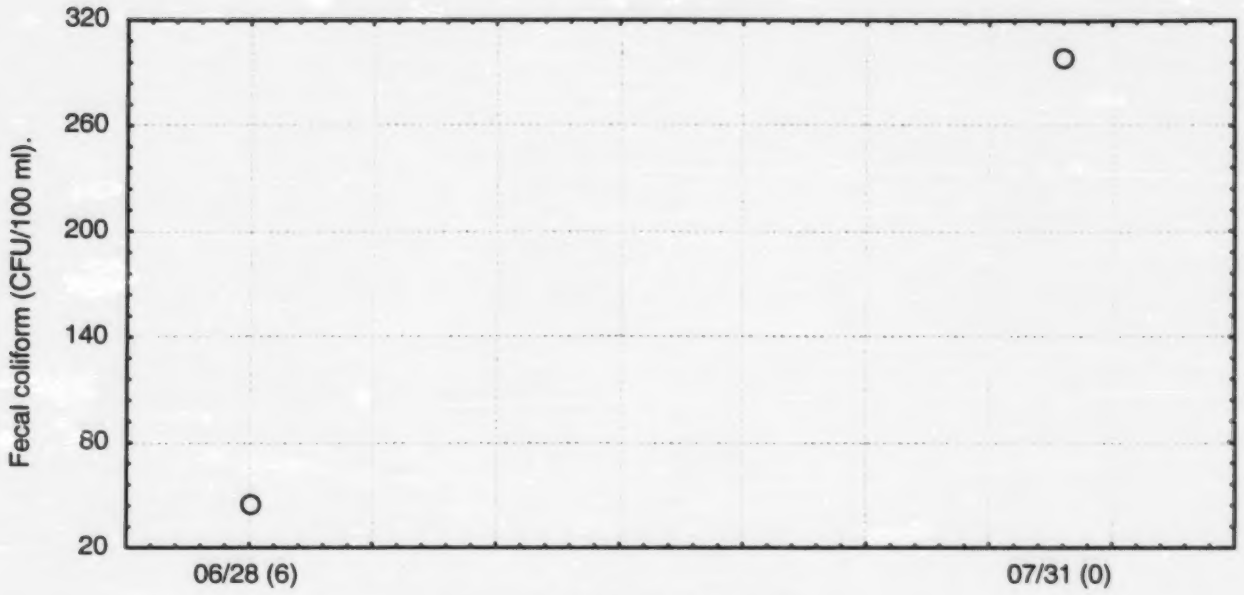
Site VM 2 appeared to drain Field VM 5 and a surrounding area. FC were low in June and July (Fig. 13), increased to near 1,000 CFU/100 ml on 19 October (before manure applied), but on October 29 (after manure applied and after rain event) had declined to a low value similar to June and July.

Site VM 1 drained a portion of Field VM 6. FC remained low on three of the four dates (no result for October 19) (Fig. 13).

FC values at both VM2 and VM1 were low after the heavy late October rain, yet manure had been applied only five to six days prior to sampling.

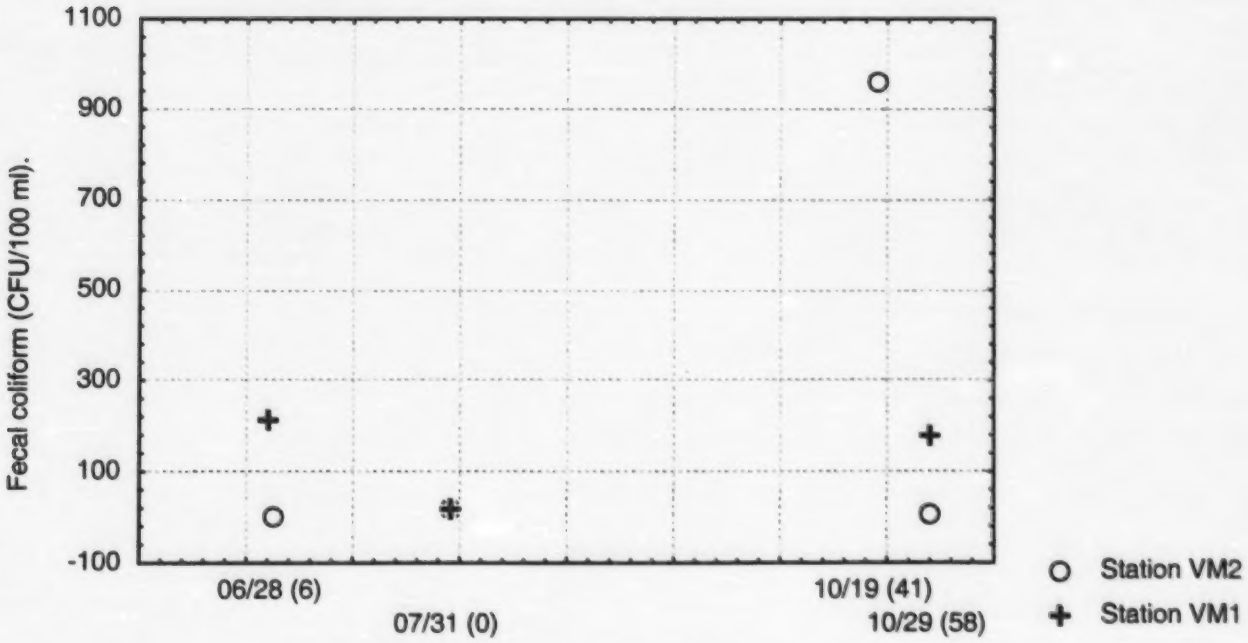
Site VM 3– most of the drainage was hay fields. A small tributary of the main stream drained a portion of Field VM 6. FC were low in late June, increased to >300 in late July, and 390 on October 29th (Fig. 14). The increase would only be considered moderate, but since the treated area was a small portion of the total drainage, it probably had little or no effect on water quality in the stream.

Fig. 12. Fecal coliform, Metz Farm study, Station VM4
June-July 2000.



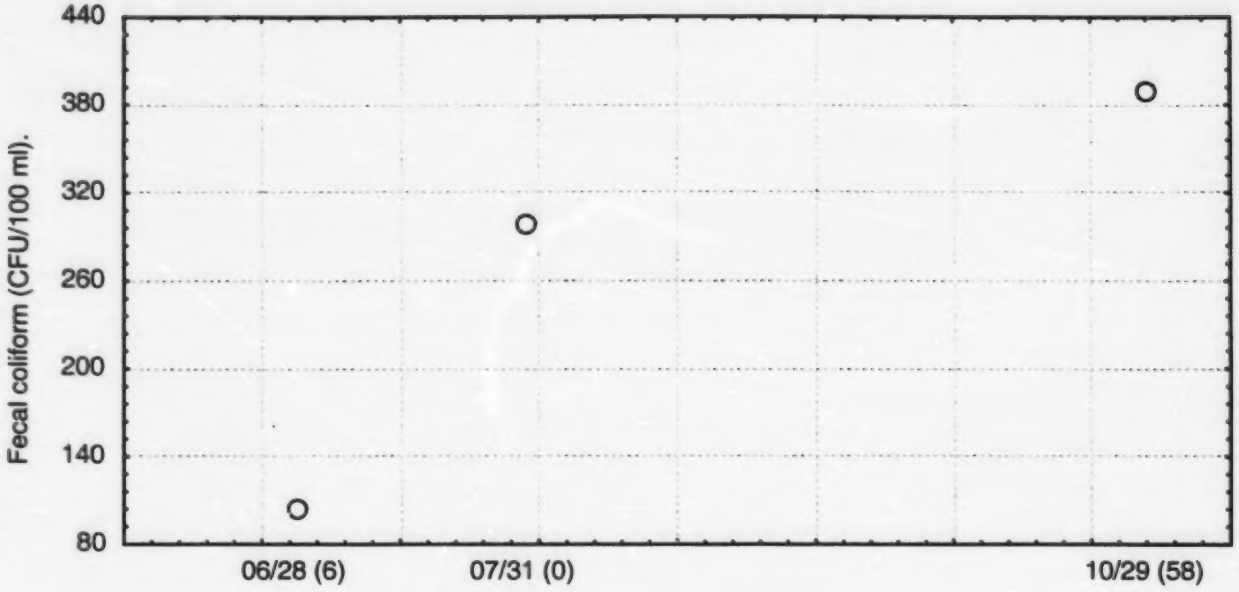
NOTE: FC, 07/31, >300 CFU/100 ml
Sampling date and previous rainfall (mm).

Fig.13. Fecal coliform, Metz Farm study,
stations VM2 and VM1, June-Oct, 2000.



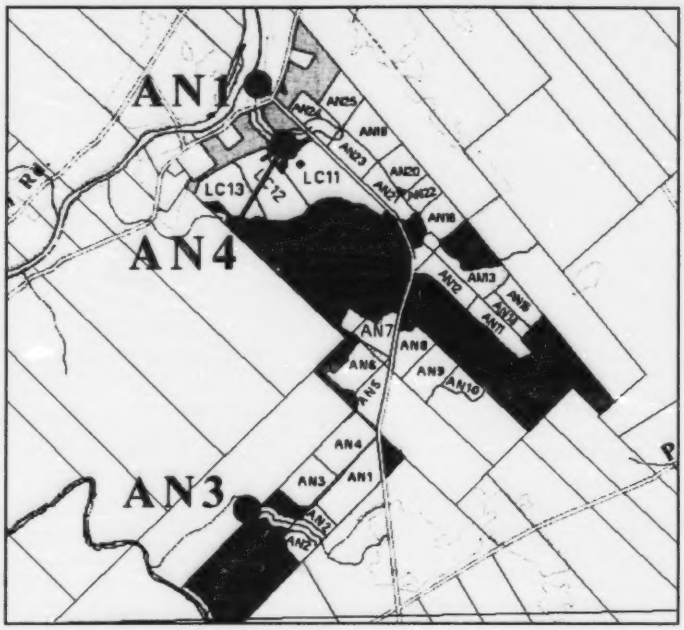
Sampling date and previous rainfall (mm).

Fig. 14. Fecal coliform, Metz Farm study,
Station VM3, June-Oct, 2000.



NOTE: FC, 07/31, >300 CFU/100 ml

Sampling date and previous rainfall (mm).



Areas AN and LC

Livestock – 100 cows, 75 calves (AN)

Manure application – Field AN 1,2,3,4 - fall (October 26,27), 40 loads
Field AN 20,21,22 – fall (October 25,26), 16 loads
Field AN 19,23 – fall (October 25,26), 10 loads
Field AN 16 – fall (October 26), 7 loads
Field AN 8,9,10 – fall (October 27), 6 loads
Field LC 11,12,13 – fall (October 25, 26), 29 loads

Fecal coliform results – see Fig. 15

Comments -

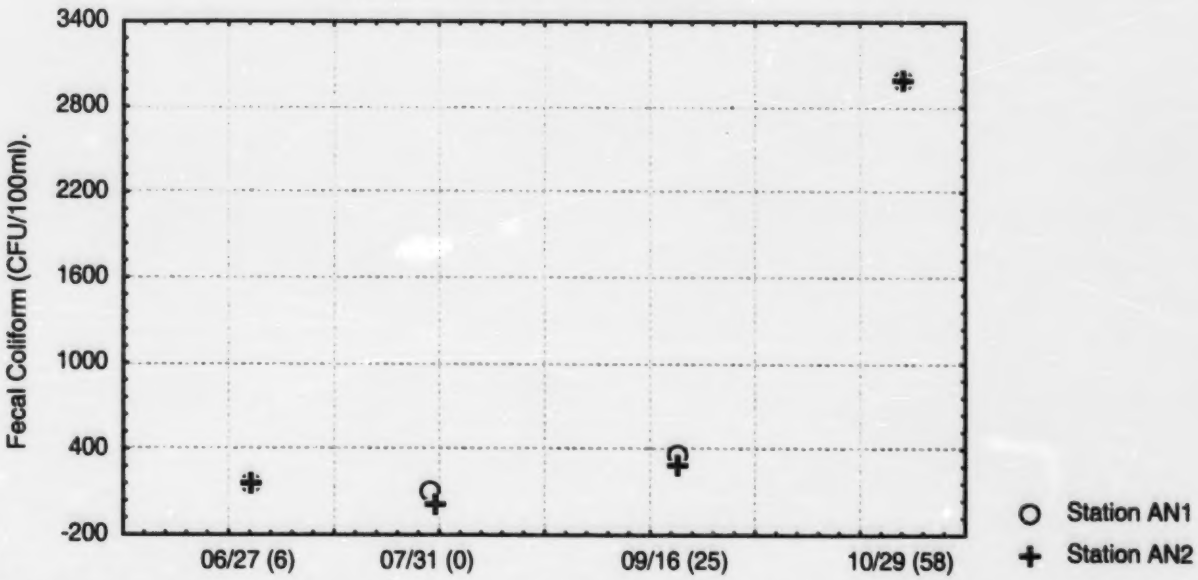
Site AN1 – downstream of treated area. Values were low in late June and July, but increased somewhat on September 16, perhaps in response to the 25 mm rainfall. FC increased to >3,000 on October 29th. Manure was applied to upstream areas on October 25 and 26, two to three days prior to a heavy rainfall. This might explain the high FC counts (>3,000 CFU/100 ml), but the influence of the cattle in the area is not known.

Site AN 4 – new station located upstream of site AN 1. The station was sampled on October 29th, and FC were 190 CFU/100 ml, much less than the >3,000 CFU/100 ml measured at Site AN 1. Since the site was much closer to the treated areas, it could be concluded that the manure application followed by rainfall did not greatly affect the small stream draining the area, and the high values measured downstream came from some other source.

Site AN 2 (not shown on map) – located on a small tributary of the Bouctouche River. The station represented drainage from fields with the AN designation, but also drained considerable area outside of the AN fields. Values were nearly identical to AN1 on June 27 and July 31. Because AN 2 results for September 16th were >300 CFU/100 ml, the extent of the increase is not known. This station also apparently responded to the heavy rainfall in late October, when FC were >3,000 CFU/100 ml. The full extent of the increase is again not known. It is also possible that livestock in the area affected the results.

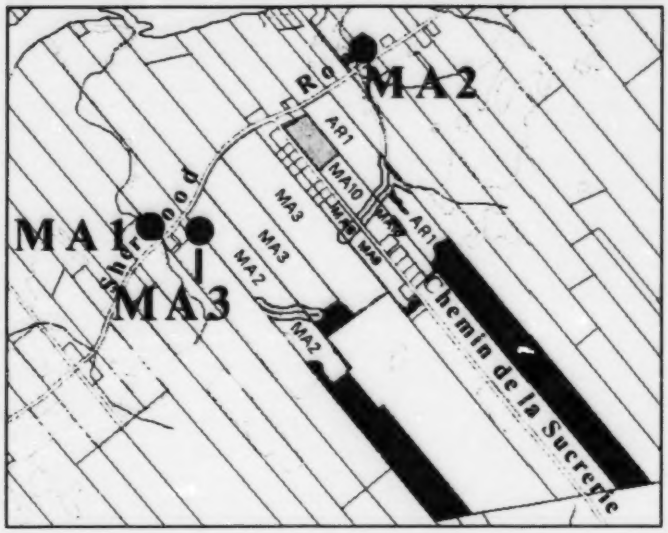
Disregarding site AN 4, it would appear that the manure applied only a few days prior to a major rainfall had a large effect on streams draining the area. However, evidence from the new site (Site AN 4) suggested that the manure from the Metz Farm did not have a large effect on the bacterial quality of runoff waters.

Fig. 15. Fecal coliform, Metz Farm study,
stations AN1 and AN2 June-Oct, 2000.



NOTE: FC at AN1,10/29,>3000CFU/100ml; AN2,09/16,>300CFU/100ml,10/29,>3000CFU/100

Sampling date and previous rainfall (mm).



Areas AR and MA

Livestock – 30 cows
80 sheep (neither cows or sheep were pastured in the treated area)

Manure application – Fields MA 2,3,8 – fall (October 13,14,18,23), 86 loads
Field MA 10 – fall (October 13), 12 loads

Fecal coliform results – see Fig. 16

Comments -

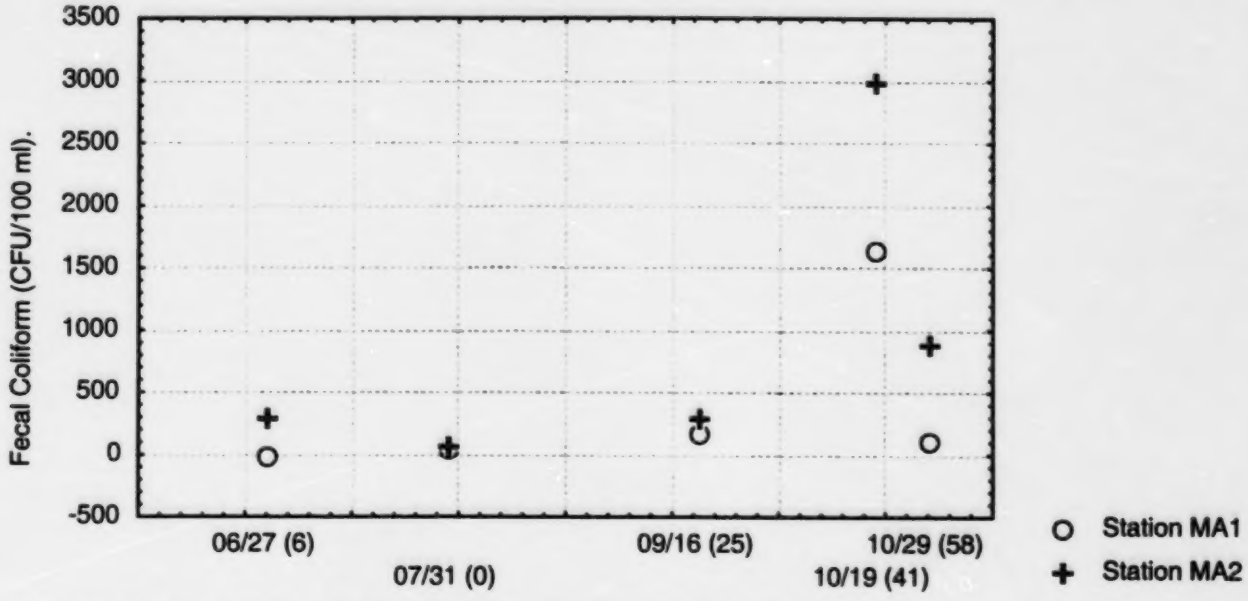
Site MA 1 – located downstream of manure application areas. The drainage included considerable area outside the treated fields and thus, results were subject to the effects of non-treated areas. FC were low in June and July, increased slightly (172 CFU/100 ml) after the September rain, climbed to 1,640 CFU/100 ml after the mid October rain, but declined to 110 CFU/100 ml after the late October rain. All manure applications but one occurred a few days prior to the mid October rain and thus may have caused the increased FC measured on October 19th. The return to low FC in late October may have been due to the presence of less FC in the fields and adjacent land areas because of flushing by the mid October runoff and bacterial die off.

Site MA 3 – new site located on a swale receiving drainagethe MA fields. This site was located to better isolate the treated area from the untreated area. FC on October 29th were 10 CFU/100 ml or about one tenth the value measured downstream at Site MA 1. This may indicate that the untreated area had greater effect on the bacteria levels at Site MA 1 than did the treated area. Further sampling is needed to establish this.

Site MA 2 – located on another stream which drains the MA and AR fields. The drainage also included areas not treated, but utilized by a local farmer for spreading of manure from his operation. The livestock mentioned above were pastured outside the treated area, but were within the drainage represented by Site MA2. Thus, they could have influenced the FC values

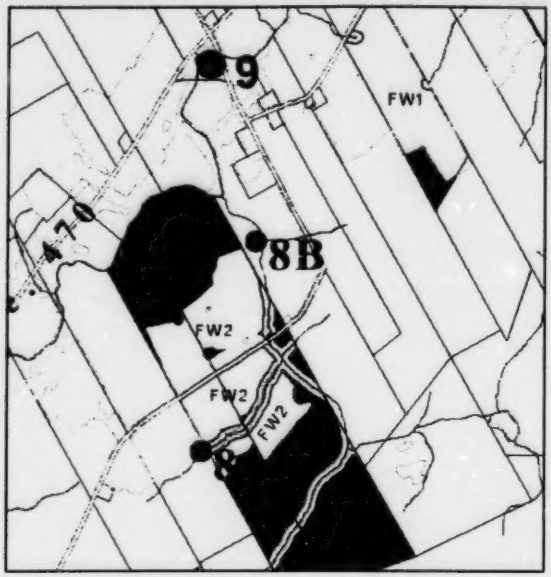
measured at this location. FC were >300 CFU/100 ml in June and September. In these cases, the absence of actual numbers prevented interpretation of the results. The value for late July was low. The mid October rain coincided with an increase of FC to >3,000 CFU/100 ml, but FC declined to 890 CFU/100 ml in late October. The decrease may have been for the same reasons described for Site MA 1. The relative contributions of FC from the treated areas manure spread on the adjacent farm, and pastured livestock are not known.

Fig.16. Fecal coliform, Metz Farm study,
stations MA1 and MA2, June-Oct, 2000.



NOTE: FC at MA2, 06/27 & 09/16, >300 CFU/100 ml; 10/19, >3000 CFU/100 ml

Sampling date and previous rainfall (mm).



Area (Field) FW 2

Livestock – 45 cows, 50 sheep

Manure application – spring (June 6 and 12), 83 loads

Fecal coliform results – see Fig. 17

Comments -

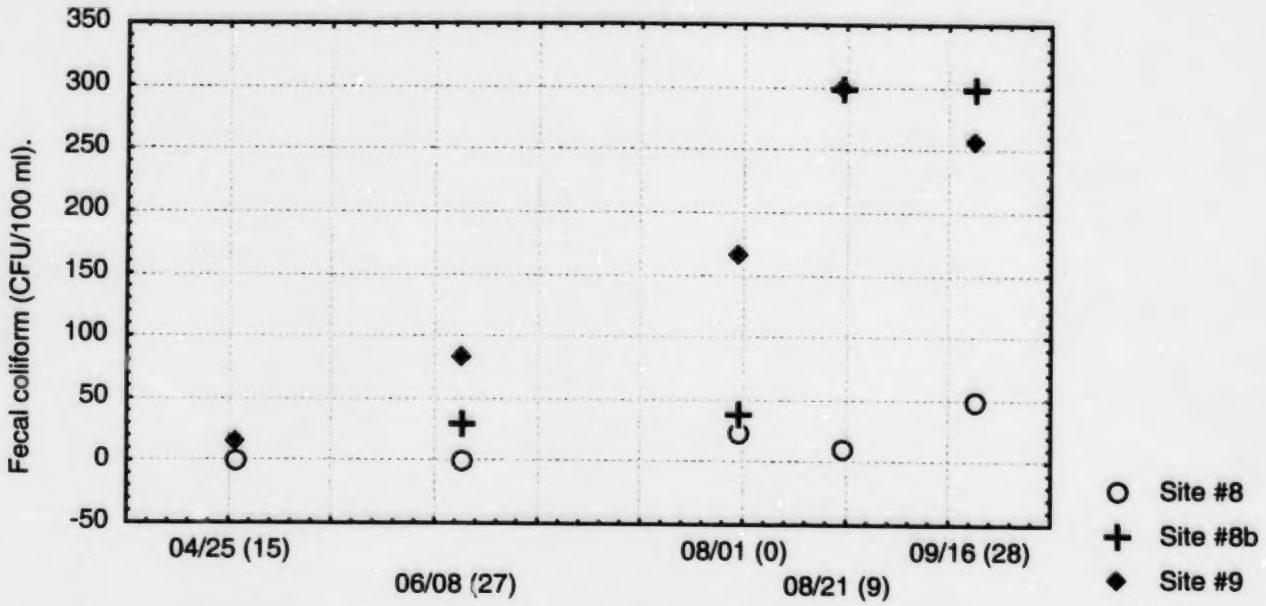
Site #8 – upstream of the treated area. FC counts were low (<100 CFU/100 ml) for all five sampling dates.

Site #8B – located a short distance downstream of the treated area. The FC concentration was low on June 8 and August 1, but increased to >300 CFU on August 21 (9mm rainfall) and September 16 (25 mm rainfall).

Site #9 – downstream of Site #8B; represented a drainage area larger than Site #8B. FC were higher than at Site #8B on August 1. Both sites were determined to be >300 CFU/100 ml on August 21, and FC at Site #9 were less than at Site #8B on September 16. Overall, values at sites #8B and #9 were considered to be of similar magnitude.

It appears that rainfall caused FC to increase, but because of the >300 CFU/100 ml values, the extent is not known. Since treatment took place one and a half months prior to sampling, it seems unlikely that by August 1 the manure would have any effect on FC numbers. The increases may have been due to the livestock pastured in the area.

Fig. 17. Fecal coliform, Metz Farm study,
sites #8, #8b, #9, April-Sept, 2000.



NOTE: FC at #8b, 08/21, 09/16, #9, 08/21, >300 CFU/100 ml

Sampling date and previous rainfall (mm).

3.4 GROUNDWATER QUALITY

Samples were taken in August through to October. The results in Table 2 represent water quality in the domestic wells prior to any spreading of liquid manure in the area by Metz Farms. Results by area are presented in Appendix B.

Table 2. Pre-spreading results

Parameter	# of samples	Range of results	Guideline	# exceeding guidelines
Total coliform	80	ND - > 200 counts/100 ml	< 10 on first sample, no two consecutive samples with presence detected	38 samples showed presence on first sample, 20 samples had > 10 counts
E-coli	80	ND - 4 counts/ 100 ml	0 counts/ 100 ml	5 samples
alkalinity	77	13.2 - 181 mg/l		
aluminum	77	LOQ - 0.088 mg/l		
arsenic	77	LOQ - 4.32 ug/l	25 ug/l	
cadmium	77	< LOQ	0.005 mg/l	
calcium	77	LOQ - 96.3 mg/l	200 mg/l	
conductivity	77	51.2 - 810 uS/cm		
copper	77	LOQ - 0.326 mg/l	1 mg/l	
fluoride	77	LOQ - 0.289 mg/l	1.5 mg/l	
iron	77	LOQ - 0.259 mg/l	0.3 mg/l	
lead	77	LOQ - 2.14 ug/l	10 ug/l	
magnesium	77	LOQ - 28.2 mg/l	150 mg/l	
manganese	77	LOQ - 0.785 mg/l	0.05 mg/l	9 samples *
nitrate	77	LOQ - 15.3 mg/l	10 mg/l	1 sample **
pH	77	6.85-9.01	6.5-8.5	2 samples
potassium	77	0.102 - 4.65 mg/l		
sodium	77	3.13-91.4 mg/l	270 mg/l	
sulphate	77	2.32 - 22.6 mg/l	500 mg/l	
turbidity	77	0-1.9 NTU	1 NTU	3 samples
zinc	77	LOQ - 0.162 mg/l	5 mg/l	
SS	77	LOQ - 24 mg/l		
TKN	77	< LOQ		
TOC	77	LOQ - 2.28 mg/l		
Total phosphorous	77	LOQ - 0.12 mg/l		
Total ammonia	77	LOQ - 0.014 mg/l		

LOQ = limit of quantification ND = no detect

* It should be noted that this guideline is based on aesthetic objectives (AO) and does not constitute a health hazard. Manganese concentrations above the AO are common in New Brunswick.

** This is a barn well. Two other wells were approaching the health advisory limit (HAL) at 9 mg/l and 9.9 mg/l of nitrate.

Follow-up samples were taken in the area around one of the fields, which had been spread with liquid manure. These samples were taken due to concerns with respect to a rainfall shortly after spreading some of the fields in this area. Before and after results are presented in Table 3.

Table 3. Pre and Post-spreading results

Sample #	well depth (ft)	casing depth (ft)	age of well	date	T.C.	E.C.
46	130		1977	10-18-00	ND	ND
				10-24-00	ND	ND
47	85		1987	08-10-00	ND	ND
				10-24-00	ND	ND
48	110	85	1973	08-10-00	ND	ND
				10-24-00	ND	ND
49	280	180?	1996	08-30-00	ND	ND
				10-24-00	ND	ND
50	spring			08-30-00	200	ND
				10-24-00	200	ND
51	115	45	1975	10-24-00	ND	ND
52			1975	08-30-00	1	ND
				10-24-00	ND	ND
53	132	60?	1991	08-10-00	ND	ND
				10-24-00	2	ND
54				08-10-00	109	ND
				10-24-00	1	ND
58	90-93		1980	10-24-00	ND	ND
59	90		1972	08-30-00	1	1
				10-24-00	ND	ND

T.C. = total coliform E.C. = *E. coli*

As can be seen from the data, most wells exhibited no change or a reduction of total coliform counts from previous sampling events. A reduction would be attributed to presumed chlorination of wells following previous positive test results. Without information pertaining to an interim test on the wells with positive counts, it is difficult to comment on the effect of spreading on the well water, except to simply examine post-spreading results. Seventy-three percent of the wells tested on October 24th showed no detection of total coliforms. One well had 2 total coliform organisms where previously there were none. This well was reportedly re-sampled a third time and no coliform organisms were detected.

Samples taken after spreading showed no detection of *E-coli*. Should spreading of the liquid manure be a cause for concern, one would expect to see *E-coli* counts. Total coliform can be produced from a variety of sources and is widespread in the natural environment. *E-coli*, is thought to be universally present in the feces of warm blooded animals. It is suggested therefore that *E-coli* would always be present in any fecal contamination event (Allen and Edberg, 1995). Thus, at this time there appears to be no relationship between the spreading of liquid manure (originating at Metz Farms) and well contamination. These are preliminary results only however, and are therefore not conclusive.

All the wells bordering fields which were spread with the liquid manure generated at Metz Farms 2 are expected to be sampled again in the near future.

4.0 CONCLUSIONS

4.1 Surface Water

General

At this early stage, it appears that the effects of manure application to lands in the vicinity of the Metz Farm have been minimal. However, because uncertainties were associated with the timing of sampling and the rate of water quality changes during and after rain events, additional data are needed to gain a more reliable impression of how the spreading of liquid manure may affect water quality.

Specific Conclusions

1. The effects of rainfall on FC bacteria at two areas (DF1 and FC1; MG) where livestock were absent and Metz Farm manure was not applied, could not be determined due to the lack of post-rainfall data.

2. The results for one area where livestock were pastured (EC,KL,PW; sampling sites #10, #11, #12, #13), but which received no Metz Farm manure, indicated about an eightfold increase in FC after a 58 mm rain event. However, the increase was evident at the background station as well as at downstream locations. The results for the other untreated, but pastured area (OM and RR), were inconclusive.

3. Two areas were not pastured, but received Metz Farm manure (Fields BM 7,8,9; Fields MA 2,3). Bacteria increases were noted downstream of Fields BM 7,8,9 after rain events in August, September and October. The application of manure more than two months prior to the August sampling, and the distance of the treated field from the sampling stations lead to the conclusion that the increase probably did not result from manure application. Increased FC downstream of fields MA 2,3 after rainfall may have resulted from both the application of manure on those fields and runoff from an adjacent non-treated area.

4. Four areas were both pastured and treated with manure (CP and BM; VM; AN and LC; Field FW2), and one (Fields MA 8,10) was treated, but livestock were pastured on an adjacent area within the same drainage. The data provided no conclusive evidence that the manure applications affected the bacterial quality of the waters draining these areas.

4.2 Groundwater

1. Background water quality data were collected for 82 wells.

2. Of nine wells sampled both before and after manure spreading, total coliform were detected in four wells prior to, and three wells after spreading. *E. Coli* were present in one and zero wells pre and post spreading, respectively.

5.0 RECOMMENDATIONS

1. While the data to date give a preliminary impression that the liquid manure management program has been effective in preventing large numbers of bacteria from reaching surface and groundwaters, continued vigilance is necessary to ensure that present practices continue.

2. The monitoring program should also continue in order to provide the greater amount of data needed to reach final conclusions.

3. The Ministerial Monitoring Committee for Metz Farms 2 Ltd. should periodically review the manure management program to determine if further measures or changes including timing and methods of application, can be implemented to provide further assurance that no adverse effects take place.

4. Likewise, the monitoring program should be regularly reviewed by the committee to determine any changes in station location, sampling frequency and methodology, and variables measured that could be implemented to improve the reliability of the data.

5. Information obtained by the Ministerial Monitoring Committee for Metz Farms 2 Ltd. should be shared with local watershed associations in order to support the goal of improving land use practices throughout the Bouctouche River Watershed.

APPENDIX A
EXAMPLE OF HOMEOWNERS QUESTIONNAIRE

GROUND WATER MONITORING PLAN FOR METZ FARMS 2 LTD

HOME OWNERS QUESTIONNAIRE

Name: _____

Address: _____

1. What is your source of drinking water?

   - Drilled well _____ If yes, year drilled _____
     Drilling Company _____
     Is well tagged? _____
     Do you have driller's report? _____
     Tag no, _____

   - Dug _____
     Spring _____
     Surface water _____

2. How deep is your well? _____

   - Casing depth _____

3. Any other wells on your property? _____

   - Which type? _____

   - Are they being used? _____

   - Have they been filled in? How? _____

     _____

4. Is the well cap above or below ground level? If below ground level, how deep?

5. Do you have a water softener?

6. Do you have an outside tap where a sample can be taken?

7. Please describe the type of soils near your well.

8. Do you wish to participate in the water sampling survey?

9. Please make a sketch of your lot indicating your home and well location and septic system.

APPENDIX B
RESULTS OF BACKGROUND MONITORING
DOMESTIC WELLS

Sample #	well depth (ft)	casing depth (ft)	age of well	date	T.C.	E.C.	alkalinity (mg/l)	Al (mg/l)	An (ug/l)	As (ug/l)	Ca (mg/l)	Cl (mg/l)	Cr (mg/l)	cond. (uS/cm)	Cu (mg/l)	Fl (mg/l)	Fe (mg/l)	Pb (ug/l)	Mg (mg/l)	Mn (mg/l)	Nitrate (mg/l)
1	95		1974	08-10-00	1	ND	112	<LOQ	<LOQ	<LOQ	26.8	2.93	<LOQ	258	<LOQ	<LOQ	<LOQ	<LOQ	5.01	0.029	<LOQ
2	85-120	60	1994	09-29-00	8	ND	88.4	<LOQ	<LOQ	<LOQ	37.9	23.1	<LOQ	310	0.06	<LOQ	<LOQ	<LOQ	6.72	0.147	3.3
3	spring			09-29-00	144	1	68.5	<LOQ	<LOQ	<LOQ	23.7	3.76	<LOQ	165	<LOQ	<LOQ	<LOQ	<LOQ	2.8	<LOQ	1.14
4	60			08-10-00	31	ND	no data														
5	spring			09-14-00	45	1	49.2	<LOQ	<LOQ	<LOQ	21.8	3.84	<LOQ	147	0.047	<LOQ	<LOQ	<LOQ	1.61	<LOQ	2.3
6	80		1983	08-10-00	ND	ND	84.4	<LOQ	<LOQ	<LOQ	38.8	7.66	<LOQ	254	<LOQ	<LOQ	<LOQ	<LOQ	3.53	<LOQ	2.1
7	100	30	1978	09-13-00	ND	ND	35.2	<LOQ	<LOQ	<LOQ	25.4	23.6	<LOQ	271	0.143	<LOQ	0.015	<LOQ	5.03	<LOQ	9.9
8				09-13-00	200	ND	104	<LOQ	<LOQ	<LOQ	71	61.6	<LOQ	587	<LOQ	<LOQ	<LOQ	<LOQ	10.6	<LOQ	***15.3***
9	110	87	1989	09-13-00	ND	ND	87	<LOQ	<LOQ	<LOQ	19.3	3.1	<LOQ	233	<LOQ	<LOQ	<LOQ	<LOQ	2.19	0.021	<LOQ
10	67	16	1952	09-13-00	ND	ND	82.6	<LOQ	<LOQ	<LOQ	41.1	9.05	<LOQ	329	0.028	<LOQ	<LOQ	<LOQ	7.13	<LOQ	6.5
11	60		"old"	06-27-00	1	ND	no data														
12			1975	10-18-00	ND	ND	39.5	<LOQ	<LOQ	<LOQ	23.6	35.1	<LOQ	234	0.021	<LOQ	<LOQ	<LOQ	5.92	<LOQ	0.78
13			1974	09-05-00	ND	ND	65.8	<LOQ	<LOQ	<LOQ	29.9	40.5	<LOQ	294	<LOQ	<LOQ	0.01	<LOQ	8.74	<LOQ	1.16
14				10-18-00	2	ND	43.9	<LOQ	<LOQ	<LOQ	21.9	36	<LOQ	246	0.085	<LOQ	0.073	<LOQ	5.41	<LOQ	0.54
15	65		1940	09-05-00	ND	ND	82	<LOQ	<LOQ	<LOQ	47.2	80.9	<LOQ	451	<LOQ	<LOQ	0.018	<LOQ	11.2	0.0075	0.97
16	64		1985	10-18-00	56	1	29.6	<LOQ	<LOQ	<LOQ	24.5	97.9	<LOQ	435	0.1	<LCQ	0.185	<LOQ	6.47	0.024	1.16
17				09-05-00	ND	ND	55.1	<LOQ	<LOQ	<LOQ	26.3	29.3	<LOQ	260	<LOQ	<LOQ	0.027	<LOQ	6.09	<LOQ	1.99
18	100		1957	09-05-00	14	ND	97.9	<LOQ	<LOQ	<LOQ	51.2	41.3	<LOQ	367	<LOQ	<LOQ	0.037	1.97	3.76	<LOQ	1.41
19	85-90	25-30	1963	09-05-00	1	ND	36.5	<LOQ	<LOQ	<LOQ	28.7	75.2	<LOQ	358	<LOQ	<LOQ	0.071	<LOQ	4.54	<LOQ	1.16
20				09-07-00	11	ND	99.1	<LOQ	<LOQ	<LOQ	46.2	38.7	<LOQ	340	0.019	<LOQ	<LOQ	<LOQ	5.1	<LOQ	1.49
21	80	20	1942	09-11-00	ND	ND	51.8	<LOQ	<LOQ	<LOQ	23.8	18.5	<LOQ	184	0.02	<LOQ	<LOQ	<LOQ	4.12	<LOQ	1.23
22				09-07-00	2	ND	41.7	<LOQ	<LOQ	<LOQ	13.6	3.68	<LOQ	109	0.106	<LOQ	<LOQ	<LOQ	2.12	<LOQ	0.47
23	30-40		1950	09-12-00	ND	ND	68.6	<LOQ	<LOQ	<LOQ	32	23.7	<LOQ	257	0.319	<LOQ	0.017	<LOQ	3.34	<LOQ	2
24				09-13-00	200	ND	97.9	<LOQ	<LOQ	<LOQ	45.3	23.7	<LOQ	321	0.03	<LOQ	0.023	<LOQ	3.56	<LOQ	1.72
25	70	30	1984	10-04-00	3	ND	114	<LOQ	<LOQ	<LOQ	51.7	38.7	<LOQ	345	0.014	<LOQ	<LOQ	<LOQ	3.74	<LOQ	0.96
26			1970	09-28-00	2	ND	114	<LOQ	<LOQ	<LOQ	33.7	4	<LOQ	251	<LOQ	<LOQ	<LOQ	<LOQ	4.76	<LOQ	<LOQ
27	80	27-30	1953	09-28-00	29	ND	148	<LOQ	<LOQ	1.64	62.7	41.2	<LOQ	451	<LOQ	<LOQ	<LOQ	<LOQ	11.2	<LOQ	0.98
28	80-85	50		09-28-00	ND	ND	88.8	<LOQ	<LOQ	<LOQ	0.183	30.1	<LOQ	290	<LOQ	<LOQ	<LOQ	<LOQ		<LOQ	1.61
29	102		1993	09-28-00	200	ND	115	<LOQ	<LOQ	<LOQ	40	8.75	<LOQ	271	<LOQ	<LOQ	0.012	<LOQ	5.34	<LOQ	0.36
30	70		1990	09-28-00	4	ND	108	<LOQ	<LOQ	<LOQ	38.4	9.28	<LOQ	258	<LOQ	<LOQ	<LOQ	<LOQ	4.88	<LOQ	0.22
31	100		1968	09-28-00	ND	ND	136	<LOQ	<LOQ	<LOQ	55.1	22.9	<LOQ	347	<LOQ	<LOQ	<LOQ	<LOQ	4.1	0.02	0.41
32	85	44	1990	10-04-00	200	ND	112	<LOQ	<LOQ	<LOQ	35.8	4.44	<LOQ	242	<LOQ	<LOQ	<LOQ	<LOQ	4.74	<LOQ	0.55
33	75	35	1945	09-28-00	200	ND	34.4	0.065	<LOQ	<LOQ	15.2	15.8	<LOQ	166	0.11	<LOQ	0.149	<LOQ	2.46	<LOQ	2.5
34				09-28-00	ND	ND	70	<LOQ	<LOQ	<LOQ	31.9	16.5	<LOQ	226	0.035	<LOQ	0.011	<LOQ	2.98	<LOQ	1.15
35				06-12-00	ND	ND	125	<LOQ	<LOQ	<LOQ	37.7	2.98	<LOQ	244	<LOQ	<LOQ	0.029	<LOQ	5.24	0.198	<LOQ
36				06-12-00	19	ND	89.9	0.088	<LOQ	<LOQ	33.6	14	0.011	226	0.132	<LOQ	0.05	<LOQ	3.64	<LOQ	0.5
37	28-30			09-28-00	200	4	131	<LOQ	<LOQ	<LOQ	48.2	3.13	<LOQ	267	0.159	<LOQ	0.046	<LOQ	3.05	0.049	<LOQ
38	85	45	1985	10-12-00	36	ND	no data														
39	145	45		10-12-00	ND	ND	no data														
40	115		1985	18-10-00	2	ND	111	<LOQ	<LOQ	<LOQ	32.2	2.66	<LOQ	231	<LOQ	<LOQ	0.057	<LOQ	3.31	0.071	<LOQ
41			1974	09-17-00	200	ND	105	<LOQ	<LOQ	<LOQ	47	22.1	<LOQ	327	0.326	<LOQ	0.027	1.4	4.58	<LOQ	4
42				09-12-00			13.2	0.04	1.51	<LOQ	4.61	2.79	<LOQ	51.2	<LOQ	<LOQ	0.043	<LOQ	0.759	0.0058	0.18
43	132	40	1981	09-28-00	ND	ND	116	<LOQ	<LOQ	<LOQ	22.7	2.76	<LOQ	248	<LOQ	0.289	<LOQ	<LOQ	2.62	0.0067	<LOQ
44				09-28-00	ND	ND	160	<LOQ	<LOQ	<LOQ	55.1	29.5	<LOQ	420	<LOQ	0.145	<LOQ	<LOQ	12.2	<LOQ	0.72
45	75	40	1980	09-14-00	ND	ND	121	<LOQ	<LOQ	<LOQ	43.7	13.3	<LOQ	306	<LOQ	<LOQ	<LOQ	<LOQ	6.48	<LOQ	1.84
46	130		1977	10-18-00	ND	ND	124	<LOQ	<LOQ	<LOQ	20	3.69	<LOQ	258	<LOQ	<LOQ	<LOQ	<LOQ	3.13	<LOQ	<LOQ
47	85		1987	08-10-00	ND	ND	150	<LOQ	<LOQ	<LOQ	56.3	8.86	<LOQ	337	<LOQ	<LOQ	<LOQ	<LOQ	5.53	<LOQ	0.53
48	110	85	1973	08-10-00	ND	ND	124	<LOQ	<LOQ	<LOQ	17.5	3.28	<LOQ	255	<LOQ	<LOQ	<LOQ	<LOQ	2.01	0.018	<LOQ
49	280	180?	1996	08-30-00	ND	ND	181	<LOQ	<LOQ	<LOQ	1.23	2.86	<LOQ	370	<LOQ	<LOQ	0.067	<LOQ		<LOQ	<LOQ
50	spring			08-30-00	200	ND	126	<LOQ	<LOQ	<LOQ	43.6	14	<LOQ	307	<LOQ	<LOQ	<LOQ	<LOQ	5.22	<LOQ	0.77

Sample #	well depth (ft)	casing depth (ft)	age of well	date	T.C.	E.C.	alkalinity (mg/l)	Al (mg/l)	An (ug/l)	As (ug/l)	Ca (mg/l)	Cl (mg/l)	Cr (mg/l)	cond. (uS/cm)	Cu (mg/l)	Fl (mg/l)	Fe (mg/l)	Pb (ug/l)	Mg (mg/l)	Mn (mg/l)	Nitrate (mg/l)
51	115	45	1975	10-24-00	ND	ND	112	<LOQ	<LOQ	<LOQ	1.72	2.53	<LOQ	297	<LOQ	<LOQ	0.011	<LOQ		<LOQ	<LOQ
52			1975	08-30-00	1	ND	122	<LOQ	<LOQ	<LOQ	13.6	3.25	<LOQ	254	<LOQ	<LOQ	<LOQ	<LOQ	3.12	<LOQ	<LOQ
53	132	60?	1991	08-10-00	ND	ND	107	<LOQ	<LOQ	2.24	17	2.91	<LOQ	234	<LOQ	<LOQ	<LOQ	<LOQ	1.43	<LOQ	<LOQ
54				08-10-00	109	ND	119	<LOQ	<LOQ	<LOQ	29.5	4.06	<LOQ	255	<LOQ	<LOQ	<LOQ	<LOQ	5.46	<LOQ	0.17
55	120			08-10-00	165	ND	120	<LOQ	<LOQ	<LOQ	29.6	4.25	<LOQ	253	<LOQ	<LOQ	<LOQ	<LOQ	5.41	<LOQ	0.17
56	102	52	1999	08-10-00	ND	ND	no data														
57	90-93			10-26-00	ND	ND	98.2	<LOQ	<LOQ	<LOQ	33.3	4.14	<LOQ	278	<LOQ	<LOQ	<LOQ	<LOQ	6.23	0.0078	0.21
58	10 to 12		1980				35.6	<LOQ	<LOQ	<LOQ	16.2	3.31	<LOQ	128	0.126	<LOQ	0.224	<LOQ	2.38	0.0076	1.46
59	90		1972	08-30-00	1	1	124	<LOQ	<LOQ	<LOQ	36.5	6.42	<LOQ	264	<LOQ	<LOQ	<LOQ	<LOQ	6.51	<LOQ	0.44
60				09-05-00	ND	ND	147	<LOQ	<LOQ	<LOQ	57.2	48.4	<LOQ	461	<LOQ	0.133	0.013	<LOQ	7.36	0.735	0.16
61	52	25-28	1975	10-12-00	24	ND	16.5	<LOQ	<LOQ	<LOQ	14.7	35.2	<LOQ	172	0.017	<LOQ	0.012	<LOQ	3.05	<LOQ	3.5
62	150	30	1970	09-06-00	ND	ND	62.4	<LOQ	<LOQ	<LOQ	19.8	3.32	<LOQ	146	<LOQ	<LOQ	<LOQ	<LOQ	1.78	0.019	<LOQ
63			1980	09-06-00	ND	ND	49.8	<LOQ	<LOQ	<LOQ	14.9	2.02	<LOQ	129	0.015	<LOQ	<LOQ	<LOQ	1.95	<LOQ	<LOQ
64	60		1962	08-14-00	3	ND	36.1	<LOQ	<LOQ	<LOQ	12.1	6.11	<LOQ	109	0.036	<LOQ	0.062	2.14	1.73	<LOQ	0.3
65	70-80		1974	09-28-00	ND	ND	85	<LOQ	<LOQ	<LOQ	31.9	3.24	<LOQ	194	<LOQ	<LOQ	<LOQ	<LOQ	3.24	<LOQ	0.47
66			1979	08-14-00	ND	ND	85.1	<LOQ	<LOQ	<LOQ	29	8.5	<LOQ	222	<LOQ	<LOQ	<LOQ	<LOQ	3.42	<LOQ	0.83
67	85	40	1974	09-06-00	1	ND	82.4	<LOQ	<LOQ	<LOQ	29	8.42	<LOQ	238	<LOQ	<LOQ	<LOQ	<LOQ	3.85	<LOQ	0.35
68	50		1950	09-06-00	ND	ND	42.1	<LOQ	<LOQ	<LOQ	20.3	23.4	<LOQ	217	0.023	<LOQ	0.018	<LOQ	2.31	<LOQ	2.4
69	150		1950	09-29-00	3	ND	61.1	<LOQ	<LOQ	<LOQ	21.5	4.28	<LOQ	147	<LOQ	<LOQ	<LOQ	<LOQ	2.2	0.0082	<LOQ
70	60-70	25-30	1950	09-06-00	9	ND	85.6	<LOQ	<LOQ	3.11	30.4	13.2	<LOQ	235	<LOQ	0.126	<LOQ	<LOQ	4.56	0.315	0.07
71				09-29-00	2	ND	136	<LOQ	<LOQ	<LOQ	72	34.9	<LOQ	480	0.045	<LOQ	<LOQ	<LOQ	8.96	0.0054	9
72	85		1993	10-18-00	ND	ND	101	<LOQ	<LOQ	<LOQ	42.6	20.3	<LOQ	304	<LOQ	0.102	0.016	<LOQ	5.99	0.06	1.66
73	144		1988	09-06-00	ND	ND	85.2	<LOQ	<LOQ	<LOQ	29.1	2.39	<LOQ	193	<LOQ	0.132	0.259	<LOQ	2.59	0.128	<LOQ
74				09-11-00	ND	ND	41.6	<LOQ	<LOQ	<LOQ	55.8	95	<LOQ	368	<LOQ	<LOQ	0.023	<LOQ	4.69	<LOQ	0.44
75	70-80		"oid"	09-11-00	ND	ND	51.1	<LOQ	<LOQ	<LOQ	25.2	8.21	<LOQ	165	<LOQ	<LOQ	<LOQ	<LOQ	2.43	0.105	<LOQ
76	85		1988	09-07-00	ND	ND	43.8	<LOQ	<LOQ	<LOQ	32.9	31.8	<LOQ	227	<LOQ	<LOQ	<LOQ	<LOQ	3.37	0.048	<LOQ
77	98	50	1950	06-27-00	10	ND	174	<LOQ	<LOQ	<LOQ	96.3	114	<LOQ	810	0.011	<LOQ	0.055	<LOQ	28.2	<LOQ	1.2
78				06-27-00	ND	ND	153	<LOQ	<LOQ	<LOQ	<LOQ	6.56	<LOQ	304	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.22
79				06-27-00	ND	ND	154	<LOQ	<LOQ	<LOQ	49.7	2.85	<LOQ	318	<LOQ	<LOQ	0.168	<LOQ	8.27	0.071	1.66
80				06-27-00	ND	ND	116	<LOQ	<LOQ	4.32	11	9.43	<LOQ	252	<LOQ	<LOQ	<LOQ	<LOQ	2.12	<LOQ	0.07
81				06-27-00	ND	ND	141	<LOQ	<LOQ	<LOQ	33.9	3.68	<LOQ	269	<LOQ	<LOQ	<LOQ	<LOQ	7.16	<LOQ	0.4
82			1995	09-14-00	ND	ND	85.6	<LOQ	<LOQ	<LOQ	28.8	7.89	<LOQ	213	<LOQ	0.124	0.025	<LOQ	4.23	0.077	<LOQ

Sample #	pH	K (mg/l)	Na (mg/l)	SO4 (mg/l)	SS (mg/l)	TOC (mg/l)	Phos. (mg/l)	Ammonia (mg/l)	Hardness (mg/l)	Turb. (NTU)	Zn (mg/l)
1	8.29	1.35	20.1	4.1	<LOQ	<LOQ	0.005	<LOQ	87.5	0	0.015
2	7.2	0.855	8.09	3.84	<LOQ	<LOQ	0.012	<LOQ	122.3	0	0.0064
3	7.35	0.87	5.29	2.58	<LOQ	<LOQ	0.029	<LOQ	70.7	0.2	0.008
4											
5	7.44	0.267	5.1	6.31	<LOQ	<LOQ	0.077	<LOQ	61.1	0	0.012
6	8.17	0.833	6.95	12.1	<LOQ	<LOQ	0.011	<LOQ	111.4	0	0.016
7	7.19	0.901	13.8	7.54	<LOQ	<LOQ	0.03	<LOQ	84.1	0	0.035
8	7.5	3.25	16	6.87	<LOQ	<LOQ	0.015	<LOQ	***220.9***	0	0.02
9	8.29	1.12	27.6	3.33	<LOQ	<LOQ	<LOQ	<LOQ	57.2	0	0.016
10	8.03	0.568	9.91	9.42	<LOQ	<LOQ	0.009	<LOQ	132	0	0.024
11											
12	7.57	0.853	9.35	7.48	<LOQ	<LOQ	0.01	<LOQ	83.3	0	0.0097
13	7.91	0.791	9.15	6.29	<LOQ	<LOQ	<LOQ	<LOQ	110.6	0	0.0077
14	7.52	1.92	15.2	8.07	<LOQ	<LOQ	0.013	<LOQ	77	0.5	0.013
15	8.06	0.816	12.9	5.5	<LOQ	<LOQ	<LOQ	<LOQ	164	0	0.017
16	7.22	1.16	46	10.7	<LOQ	1.06	0.005	<LOQ	87.8	***1.9***	0.012
17	7.63	0.556	9.74	16	<LOQ	<LOQ	<LOQ	<LOQ	92	0.2	0.021
18	7.86	0.539	15.9	8.39	<LOQ	<LOQ	0.005	<LOQ	143.3	0.2	0.107
19	7.23	0.969	26.1	6.86	<LOQ	<LOQ	0.007	<LOQ	90.4	0.6	0.086
20	8.06	0.899	8.14	3.34	<LOQ	<LOQ	0.01	<LOQ	136	0	0.017
21	7.81	0.506	6.82	3.2	<LOQ	<LOQ	0.006	<LOQ	76.4	0	0.0061
22	7.54	0.414	4.67	3.45	<LOQ	<LOQ	0.0021	<LOQ	42.7	0	0.0081
23	7.59	0.8	12.8	5.81	<LOQ	1.15	0.023	<LOQ	93.7	0	0.082
24	7.96	0.908	8.71	5.19	<LOQ	<LOQ	0.007	<LOQ	127.8	0	0.162
25	8.23	1.06	9.86	4.5	<LOQ	<LOQ	0.007	<LOQ	144.5	0	0.032
26	8.33	1.46	10.9	2.98	<LOQ	<LOQ	0.008	<LOQ	103.7	0	0.02
27	8.13	3.03	9.96	5.04	<LOQ	1.39	0.01	<LOQ	***202.7***	0	0.018
28	7.27	0.102	74.3	3.88	<LOQ	1.97	0.021	<LOQ	0.9	0	0.0067
29	8.29	1.04	7.56	7.31	<LOQ	<LOQ	0.009	<LOQ	121.9	0	0.015
30	8.29	0.971	6.65	4.53	<LOQ	<LOQ	0.009	<LOQ	116	0	0.017
31	8.25	0.975	9.44	3.98	<LOQ	<LOQ	0.005	<LOQ	154.5	0	0.12
32	8.13	1.2	8.8	5.53	<LOQ	<LOQ	<LOQ	<LOQ	109	0	0.016
33	7.33	1.48	12.2	9.81	<LOQ	1.09	0.021	<LOQ	48.1	***1.4***	0.043
34	7.81	0.589	7.07	3.39	<LOQ	<LOQ	0.016	<LOQ	91.9	0	0.039
35	8.14	1.44	10.6	4.45	<LOQ	1.69	0.12	<LOQ	115.7	0	0.013
36	7.44	1.25	9.04	3.95	<LOQ	2.28	0.012	<LOQ	98.9	0.7	0.0087
37	7.91	0.526	5.5	3.62	<LOQ	1.07	0.023	<LOQ	132.9	0.1	0.022
38											
39											
40	8.29	1.43	10.8	2.82	<LOQ	<LOQ	0.005	<LOQ	94	0.1	0.029
41	7.43	1.56	8.81	6.16	<LOQ	1.21	0.039	<LOQ	136.2	0	0.092
42	7.22	0.98	3.65	3.22	<LOQ	2.22	0.05	0.014	14.6	0.8	0.011
43	8.4	0.761	26.8	5.87	<LOQ	<LOQ	0.008	<LOQ	87.5	0	0.011
44	8.27	0.951	11.5	5.56	<LOQ	1.06	0.008	<LOQ	187.8	0	0.061
45	8.23	1.57	8.54	5.79	<LOQ	<LOQ	<LOQ	<LOQ	135.8	0	0.041
46	8.37	1.52	32.3	4.75	<LOQ	<LOQ	<LOQ	<LOQ	62.8	0	0.017
47	8.22	1.38	7.71	3.6	<LOQ	<LOQ	0.013	<LOQ	163.3	0	0.028
48	8.35	1.33	39.2	4.51	<LOQ	<LOQ	0.005	<LOQ	52	0	0.017
49	9.01	0.532	91.4	8.36	<LOQ	<LOQ	0.009	<LOQ	3.5	0.8	<LOQ
50	8.13	2.03	11.9	4.72	<LOQ	<LOQ	0.012	<LOQ	130.4	0.1	0.102

Sample #	pH	K (mg/l)	Na (mg/l)	SO4 (mg/l)	SS (mg/l)	TOC (mg/l)	Phos. (mg/l)	Ammonia (mg/l)	Hardness (mg/l)	Turb. (NTU)	Zn (mg/l)
51	8.69	0.412	65.4	6.8	<LOQ	<LOQ	0.007	<LOQ	4.68	0	0.01
52	8.4	1.78	39.1	5.57	<LOQ	<LOQ	0.013	<LOQ	46.8	0	0.012
53	8.35	1.15	35.5	6.23	<LOQ	<LOQ	0.007	<LOQ	48.3	0	0.015
54	8.34	1.86	17	4.15	<LOQ	<LOQ	0.007	<LOQ	96.1	0	0.02
55	8.33	1.91	17.1	4.04	<LOQ	<LOQ	0.01	<LOQ	96.2	0	0.013
56											
57	8.15	1.82	11	3.31	<LOQ	<LOQ	0.011	<LOQ	109	0	0.032
58	7.5	4.65	19.8	14.4	<LOQ	1.26	0.018	<LOQ	50.2	0.8	0.023
59	8.3	1.87	10.8	4.12	<LOQ	<LOQ	0.009	<LOQ	117.9	0	0.022
60	8.13	0.733	13	4.22	<LOQ	<LOQ	<LOQ	<LOQ	173.1	0	0.022
61	6.85	0.669	12.1	3.02	<LOQ	<LOQ	0.02	<LOQ	49.3	0	0.019
62	8.2	0.756	7.18	4.79	<LOQ	<LOQ	0.009	<LOQ	56.8	0.1	0.012
63	8.05	0.551	3.13	4.12	<LOQ	<LOQ	0.019	<LOQ	45.2	0	0.0071
64	7.52	0.476	3.27	2.32	<LOQ	<LOQ	0.013	<LOQ	37.3	0.4	0.01
65	8.13	0.838	4.82	3.35	<LOQ	<LOQ	<LOQ	<LOQ	93	0	0.027
66	8.29	0.727	4.46	4.17	<LOQ	<LOQ	0.007	<LOQ	86.5	0	0.0082
67	8.33	0.803	7.05	7.84	<LOQ	<LOQ	0.005	<LOQ	88.3	0	0.018
68	7.86	1.38	9.74	8.05	<LOQ	<LOQ	0.018	<LOQ	60.2	0	0.0097
69	8.24	0.738	6.43	6.02	<LOQ	<LOQ	0.009	<LOQ	62.7	0	0.0097
70	8.17	1.32	6.22	9.09	<LOQ	<LOQ	0.018	<LOQ	94.7	0	0.013
71	7.77	3.18	11.4	13.2	<LOQ	<LOQ	0.014	<LOQ	***216.7***	0	0.02
72	8.15	1.82	7.84	10.8	<LOQ	<LOQ	0.006	<LOQ	131	0	0.013
73	8.18	0.767	8.29	7.29	<LOQ	<LOQ	0.009	<LOQ	<LOQ	***1.7***	0.0053
74	8.02	2.04	5.77	8.7	<LOQ	<LOQ	<LOQ	<LOQ	158.6	0	0.021
75	8.14	0.529	4.23	22.6	<LOQ	<LOQ	0.01	<LOQ	72.9	0	<LOQ
76	8.05	0.981	5	15.2	<LOQ	<LOQ	0.007	<LOQ	<LOQ	0	<LOQ
77	7.67	2.09	23.8	5.08	<LOQ	1.04	0.006	<LOQ	***356.6***	0	0.084
78	7.99	0.302	75.9	5.67	<LOQ	<LOQ	0.007	<LOQ	0.7	0	<LOQ
79	8.05	1.09	9.81	3.64	24	<LOQ	0.008	<LOQ	158.1	0.3	0.028
80	8.57	1.5	43.7	7.02	<LOQ	<LOQ	0.01	<LOQ	36.2	0	0.018
81	8.2	2.43	16.3	4.73	<LOQ	<LOQ	0.007	<LOQ	114.1	0	0.016
82	8.2	0.475	8.24	7.89	<LOQ	<LOQ	0.007	<LOQ	89.3	0	0.019